United States
Department of
Agriculture

Economic
Research
Service

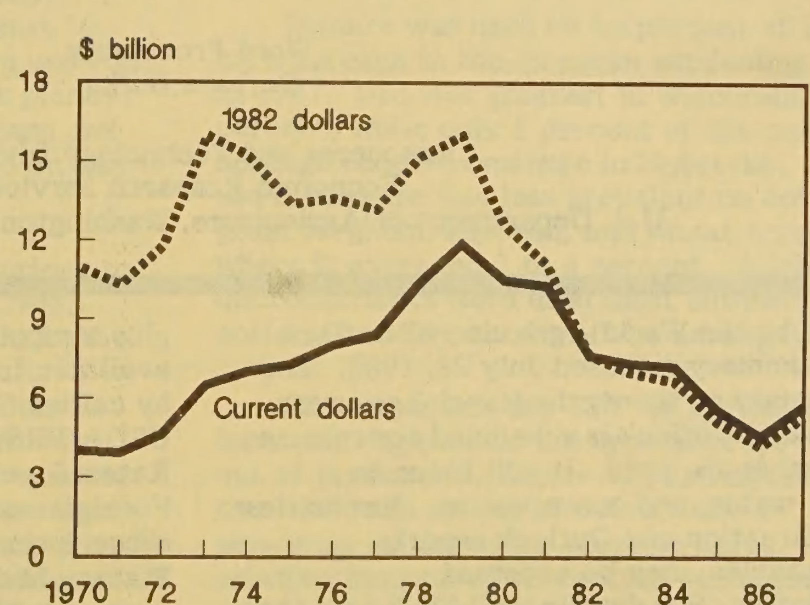
AR-11
July 1988

Agricultural Resources

Inputs

Situation and Outlook Report

Farm Machinery Expenditures



CONTENTS

Situation Coordinator
Herman Delvo

Principal Contributors
(202) 786-1456

LeRoy Hansen (Farm Machinery)
Richard Nehring, Mohinder Gill (Energy)
Mohinder Gill, Stan G. Daberkow (Seeds)
Harold Taylor, Harry Vroomen (Fertilizer)
Herman W. Delvo (Pesticides)

Statistical Assistants
Thelma Anderson
David Plante
Steven Smith

Word Processing
Barbara Burke

Resources and Technology Division
Economic Research Service
U.S. Department of Agriculture, Washington, D.C. 20005-4788

Approved by the World Agricultural Outlook Board. Summary released July 28, 1988. The next summary of the *Agricultural Resources Situation and Outlook* is scheduled for release on September 23, 1988. It will focus on cropland, water, and conservation. Summaries and full Situation and Outlook reports, including tables, may be accessed electronically. For details, call (202) 447-5505.

Agricultural Resources Situation and Outlook is published 5 times a year (4 regular issues plus a supplement). Subscriptions are available from the Economic Research Service by calling (301) 953-2515 or writing USDA/ERS, Box 1608, Rockville, MD 20850. Rates: 1 year $10, 2 years $19, 3 years $27. Foreign customers add 25 percent for subscriptions mailed outside the United States. Make check payable to USDA/ERS.

Subscriptions also are available from the U.S. Government Printing Office.

SUMMARY

The drought is expected to have little impact on 1988 expenditures for seed, fertilizer, and pesticides because most of these inputs were applied at or before planting. Farm machinery expenditures are projected to increase again in 1988, but could be slowed by the drought. Energy expenditures for irrigation will be up, but likely will be more than offset by decreased outlays for harvesting and drying.

Expenditures for farm machinery increased $1.2 billion to $5.8 billion in 1987, ending 7 years of decline. A record $56 billion in net farm cash income allowed farmers to improve their debt–asset position for the second year in a row.

Sales incentives on over–99 horsepower (hp) two–wheel–drive tractors have reduced April 1988 inventories to a 3.5–month supply relative to the previous 12 months' sales. Inventories of combines and 40–99 hp tractors are now in line with the industry's 6– to 8–month supply goal. However, inventories of four–wheel–drive tractors represent a 10–month supply and haying equipment and forage harvestors a 13–month supply, indicating continued industry overproduction.

The age distribution of tractors used in tillage and planting indicates that many tractors remain in operation for at least 10 years. In 1987, moldboard plows were used on an estimated 5 to 22 percent of acres planted to corn, cotton, soybeans, grain sorghum and wheat, while no–till planting was used on less than 5 percent of the crop acres.

U.S. farmers can expect energy prices to fall slightly during the remainder of 1988, following an increase of only 1 percent in the first half of the year. Refining capacity constraints led to tight supplies for some petroleum products this summer. However, sharply lower crude oil prices in first–quarter 1988 and prospects of fundamentally weak oil markets through the end of the year should result in somewhat lower average petroleum product prices paid by farmers in 1988 than in 1987. Earlier this year, farm energy expenditures were projected to be around $7 billion. They are now forecast 1–3 percent below this level because of the drought.

In 1988, total seed use for eight major field crops is expected to be up less than 1 percent. Prices paid by farmers for grain sorghum, oats, wheat, and soybean seed increased 3, 10, 6, and 5 percent, respectively, from 1987. However, seed prices for potatoes fell 10 percent, while those for corn and cotton declined 1 percent.

Most grass seed prices rose again in 1988, as 8 million additional Conservation Reserve Program (CRP) acres were seeded. Seed price increases ranged from 1 percent for orchardgrass to 23 percent for timothy grass. Because of the sudden rise in domestic demand generated by the CRP, the value of U.S. forage seed imports rose 69 percent in 1987.

Plant nutrient use in 1987/88 is projected to have increased slightly to about 19.4 million tons due to relatively stable crop acreage for 20 principal crops and higher commodity prices. This would be the first increase in fertilizer use since 1983/84. In April, fertilizer prices rose nearly 13 percent from a year earlier due to low U.S. inventories, stable–to–increasing domestic consumption, an anti–dumping case against Canadian potash producers, and a strong export market for nitrogen and phosphate fertilizers. Nitrogen exports advanced 11 percent, while phosphate exports fell 4 percent from the strong export market in 1986/87.

Manure was used on 16 percent of the corn acreage in the 10 major producing States in 1987. Use was greatest in Wisconsin at 43 percent, while only 1 percent of the corn acreage received manure in Nebraska. The use of manure was less prevalent on cotton, grain sorghum, soybean, and wheat acreage, where it averaged 2 to 4 percent. Sulphur and micronutrients were used most extensively on cotton (7 and 9 percent of the acreage).

The impact of the CRP on agricultural input use depends on the type of crops taken out of production, degree of participation in the CRP, and extent of substitution of non–program acres for program acres. The relative impacts of three CRP scenarios were compared to a no–CRP scenario. Agricultural input use was 4 percent lower for CRP scenarios than for no–CRP in 1987, and was 10 percent lower annually for 1990–96. The effect on cropland planted, cropping patterns,

and input use varied by region depending on the CRP scenario analyzed.

Pesticide use on 10 major field crops in 1988 is projected at 439 million pounds active ingredient (a.i.), up 2 percent from 1987. Acres planted to these crops declined 1 percent to 243.4 million in 1988, but the acreage of pesticide-intensive crops--corn, soybeans, cotton, peanuts, and rice--was up.

Greater pesticide demand helped raise average farm-level herbicide prices 3.7 percent ($4.20 per pound a.i.) and insecticide prices 3.1 percent ($10.57) between 1987 and 1988. Greater corn and soybean plantings likely increased the demand for alachlor, a major herbicide for these crops, leading to a 5.4-percent price increase. Methyl parathion prices rose 4.3 percent as supplies tightened in anticipation of heavy boll weevil infestations in 1988.

Drought Has Small Effect On Farmers' Input Demand

Nationwide, the drought will have little immediate effect on farm input industries. Businesses that manufacture or distribute agricultural inputs have, so far, been almost unscathed by the drought, since rainfall was near normal when farmers purchased most of the seed, fertilizer, and pesticides needed for 1988 spring planting. Of course, if accounts receivable become uncollectible or if late crops were not planted, as may be the case in some areas, input suppliers will be adversely affected.

The farm machinery industry will be hurt if farmers with reduced cash receipts put off buying new equipment. Demand for harvesting, drying, and storage equipment is most likely to be affected. However, irrigation equipment sales are reported to be very brisk in some areas of the country.

Energy expenditures are forecast to be off 1-3 percent from a year earlier. Energy consumption will increase for some types of farms and decrease for others. Farmers with fewer harvested acres, lower yields, and less need for drying will lower their energy consumption. However, farms that irrigate will increase energy consumption because the 1988 irrigation season began early. These farms may have to pump more water and pump from greater depths.

Input industry prospects for spring planting next year appear promising since the 1988 drought will reduce commodity stocks and increase commodity prices. This should increase planted acreage in 1989 and thereby increase input demand.

FARM MACHINERY

Demand

Farm machinery expenditures increased in 1987, ending 7 years of decline. Expenditures for tractors rose $340 million to $1.85 billion and for other farm machinery rose $830 million to $3.09 billion. Sales are likely to improve again in 1988 to near the nominal levels of 1985.

Improved farm machinery sales stem from enhanced financial conditions for farmers. Net farm cash income reached a record $56 billion in 1987 and is expected to be about the same in 1988. Land values in February 1988 showed a 3-percent gain over the previous year and are expected to increase again in 1988. Total farm debt is at its lowest level since 1979 (table 1).

Higher interest rates and drought likely will repress some demand for machinery in the remainder of 1988, but sales are still likely to rise. Real (inflation adjusted) and nominal interest rates edged downward in 1987, but have averaged 0.2 percentage points higher than the 1987 average in the first two quarters of 1988. Low precipitation and abnormally high temperatures continue to lower the potential corn and spring wheat yields.

Importance of Higher Farm Incomes

Record net cash income has played a significant role in boosting farm machinery

Table 1.--Trends in U.S. farm investment expenditures and factors affecting farm investment demand

Item	1983	1984	1985	1986	Preliminary 1987	Forecast 1988
			Billion dollars			
Capital expenditures:						
Tractors	2.61	2.54	1.94	1.51	1.85	1.9-2.3
Other farm machinery	4.74	4.68	3.65	3.09	3.92	3.8-4.2
Total	7.35	7.22	5.59	4.61	5.77	5.7-6.2
Tractor and machinery repairs	3.7	3.8	3.7	3.7	3.7	3.8-4.2
Trucks and autos	2.0	2.0	1.8	1.7	1.9	1.6-1.9
Farm buildings 1/	3.3	3.3	2.3	2.1	2.2	2.4-2.6
Factors affecting demand:						
Interest expenses	21.4	21.1	18.7	16.9	15	13-15
Total production expenses	140	143	134	122	120	123-126
Outstanding farm debt 2/ 3/	206	204	188	167	154	145-149
Farm real estate assets 2/	801	694	607	554	567	575-595
Farm nonreal estate assets 2/ 3/	249	256	240	235	247	245-255
Agricultural exports 4/	34.8	38.0	31.2	26.3	27.9	33.5
Net farm income	12.7	32.0	32.3	37.5	46	40-45
Net cash income	37.1	38.8	47.3	52.0	56	53-59
Direct Government payments	9.3	8.4	7.7	11.8	17	11-13
			Million acres			
Diverted acres 5/	78	27	31	46.7	75.7	79.6
			Percent			
Real prime rate 6/ 7/	7.0	8.3	6.7	5.7	5.3	6.0
Nominal farm machinery and equipment loan rate 8/	14.3	14.6	13.7	12.2	11.5	10/ 11.7
Real farm machinery and equipment loan rate 7/	10.5	10.8	10.5	9.6	8.6	8.8
Debt-asset ratio 9/	19.5	21.5	22.1	21.4	18.9	18-19

1/ Includes service buildings and structures and land improvements. 2/ Calculated using nominal dollar balance sheet data, including farm households for December 31 of each year. 3/ Excludes CCC loans. 4/ Fiscal year. 5/ Includes acres idled through commodity programs and acres enrolled in the Conservation Reserve. 6/ Monthly average. 7/ Deflated using 1982 GNP Deflator. 8/ Average annual interest rate. From the quarterly sample survey of commercial banks: Agricultural Financial Databook, Board of Governors of the Federal Reserve System. 9/ Outstanding farm debt (including households) divided by the sum of farm (including households) real and nonreal estate asset values. 10/ Average of the first and second quarters of 1988.

sales. Greater cash flow not only provides cash for machine purchases, but has stimulated a rise in farm asset values and has allowed farmers to reduce their debt. Improved equity increases farmers' ability to finance machinery purchases.

Lower debt and higher asset values in 1987 reduced the farm debt-asset ratio for the second year in a row. The debt-asset ratio fell to 19 percent in 1987 and is expected to fall again in 1988 as farm real estate asset values approach $600 billion.

Government Programs Increase Optimism

The rise in farm asset values indicates that farmers are more optimistic about future agricultural profits. Government programs, with direct Federal payments to farmers reaching a record $17 billion in 1987, have helped generate this optimism.

Farmers' more positive view on future commodity prices also encouraged farm machinery purchases in 1987. A brighter outlook on commodity prices results, in part, from prospects for lower stocks. Acreage reduction programs, which are expected to idle 80 million acres of cropland in 1988, helped reduce commodity stocks. Lower commodity loan rates, a lower-valued U.S. dollar, and export promotion programs such as the Export Enhancement and Targeted Export Assistance Programs have helped increase agricultural exports. For example, a recent study found that nearly one-third of the rise in wheat exports since 1985/86 can be attributed to the Export Enhancement Program. Commodity stocks are expected to fall again in 1988/89, possibly reaching their lowest level since 1985/86.

Drought

The drought in the Corn Belt and spring wheat States likely will hurt farm machinery sales, especially sales of harvesting, drying, and storage equipment. However, those farmers who produce a crop will benefit from higher commodity prices. Farm machinery purchases by farmers not affected by the drought are expected to rise.

How much commodity prices rise depends, in part, on stocks. By the end of the 1988 crop year, wheat stocks may be down to less than 30 percent of annual use. Wheat prices are currently projected to be $.90-$1.40 per bushel higher in 1988/89 than the $2.57 of 1987/88. Corn stocks on September 1, 1989, may represent 30-35 percent of 1987/88 use. Corn prices have not been quite as sensitive to lower yields as wheat prices. However, should continued drought lower yields beyond present expectations, corn stocks would be further reduced and prices would exceed projections. Soybean stocks this fall may be down to 14 percent of annual use and likely will be lower by next fall. Consequently, mid-July soybean prices, at around $8.50 per bushel, were about $3.00 over last fall's price.

Higher Interest Rates

Interest rates in the first half of 1988 appear to be higher in both real and nominal terms. Interest rates, as measured by the Federal Reserve's nominal farm machinery and equipment loan rate, had been edging downward until the fourth quarter of 1987 when they rose more than one percentage point.

Higher interest rates affect machinery purchases in two ways. First, higher interest rates decrease farm liquidity. Cash flow is reduced as the cost of debt servicing rises. Farmers also lose their capacity to borrow as their asset values fall in response to the higher rates. Second, interest rate changes can directly affect the cost of a capital purchase. Hence, higher interest rates may limit the growth of farm machinery expenditures in 1988.

Unit Sales

Sales of new over-99 horsepower (hp) two-wheel-drive tractors increased 12 percent in 1987--the first increase in 7 years (table 2). Sales of four-wheel drive tractors and combines were off 19 and 6 percent, respectively, from 1986. Sales of all tractors of over-40 hp, combines, forage harvesters, balers, and mower conditioners are forecast to rise this year to near 1985 levels.

Combine and four-wheel-drive tractor sales for the first 5 months of 1988 were 103 and 201 percent higher than the same period last year. But these high percentage increases may be misleading because sales reached such low levels a year ago. Compared with the

Table 2.--Domestic farm machinery unit purchases

Machinery category	Annual average 1978-80	Annual average 1981-84	1985	1986	1987	Forecast 1988	Change 1986-87	Change 1987-88
	Units						Percent	
Tractors:								
Two-wheel drive								
40-99 hp	62,818	42,131	37,847	30,848	30,718	32,000	*	4
Over-99 hp	59,543	31,272	17,700	14,262	15,911	17,000	12	7
Four-wheel drive	10,276	6,385	2,912	2,037	1,653	2,100	-19	27
Grain and forage harvesting equipment:								
Self-propelled combines	29,834	16,805	8,411	7,660	7,172	7,600	-6	6
Forage harvesters 1/	11,145	5,093	2,460	2,164	2,280	2,400	5	5
Haying equipment:								
Balers 2/	17,501	9,975	7,038	5,734	5,352	5,500	-7	3
Mower conditioners	23,392	14,954	11,243	10,898	11,239	12,000	3	7

* = Less than 1 percent. 1/ Shear bar type. 2/ Producing bales up to 200 pounds.

Source: Historical data are from the Farm and Industrial Equipment Institute (FIEI). All 1988 values are ERS forecasts.

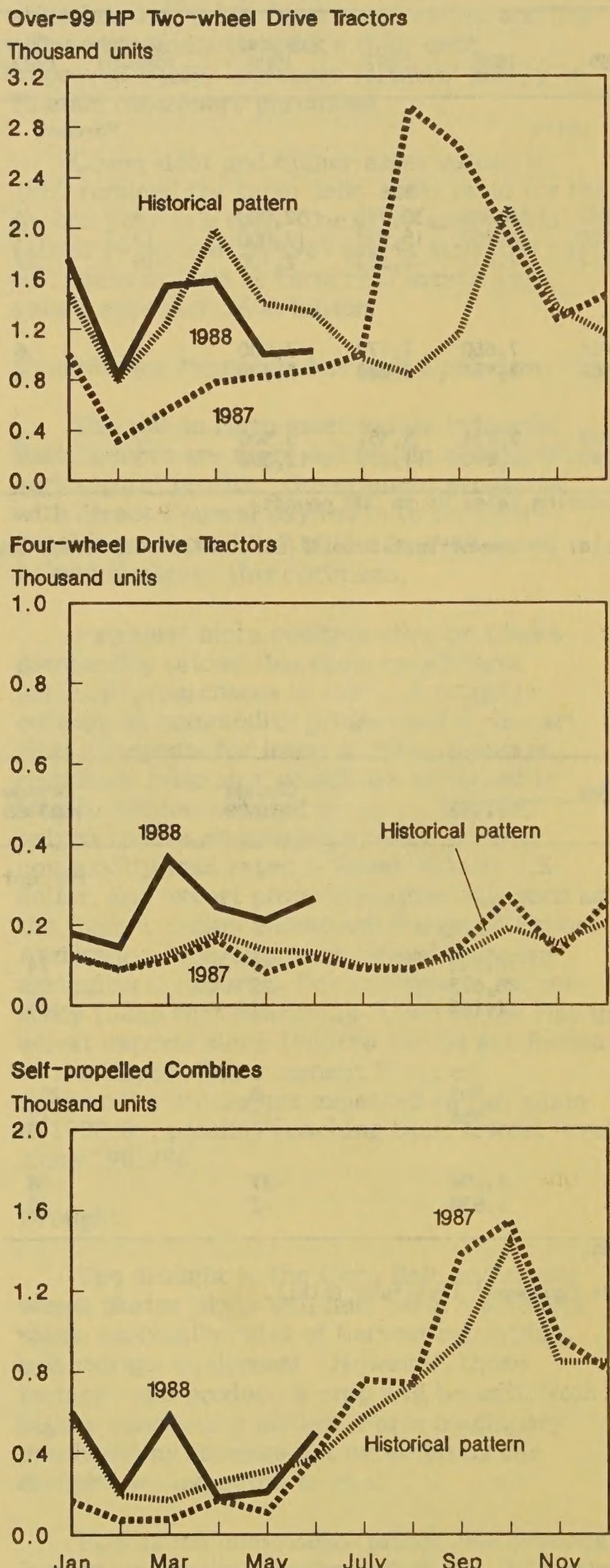
Table 3.--Domestic 5-month farm machinery unit sales

Machinery category	January--May 1985	January--May 1987	January--May 1988	Change 1985-88	Change 1987-88
	Units			Percent	
Tractors:					
Two-wheel drive					
40-99 hp	15,868	11,396	14,142	-11	24
Over-99 hp	8,946	3,762	6,675	-25	77
Four-wheel drive	1,139	564	1,146	1	103
Grain and forage harvesting equipment:					
Self-propelled combines	1,909	595	1,793	-6	201
Forage harvesters 1/	621	496	556	-10	12
Haying equipment:					
Balers 2/	2,312	1,326	1,698	-27	28
Mower conditioners	3,922	3,195	3,838	-2	20

1/ Shear bar type. 2/ Producing bales up to 200 pounds.

Source: Historical data are from the Farm and Industrial Equipment Institute (FIEI).

Farm Equipment Unit Sales



first 5 months of 1985, combine and four-wheel-drive tractor unit sales represent only a 1 and -6 percent difference (table 3).

Sales of new tractors began to increase in late July last year. Sales rose sharply when a major manufacturer introduced significant price cuts on large two-wheel-drive tractors in an effort to clear inventories. Other manufacturers followed with sales incentives of their own. The increase in sales from these incentives offset the lower sales of first-half 1987, leaving sales of large two-wheel-drive tractors 12 percent higher in 1987. The incentives caused 1987 sales of these units to deviate significantly from normal patterns.

Sales of four-wheel-drive tractors and combines followed normal seasonal patterns throughout 1987, but jumped in March 1988---an aberration from the normally constant first quarter patterns. It is not clear what role price incentives played in sparking the March sales, but more recent sales are more closely aligned to their historical patterns.

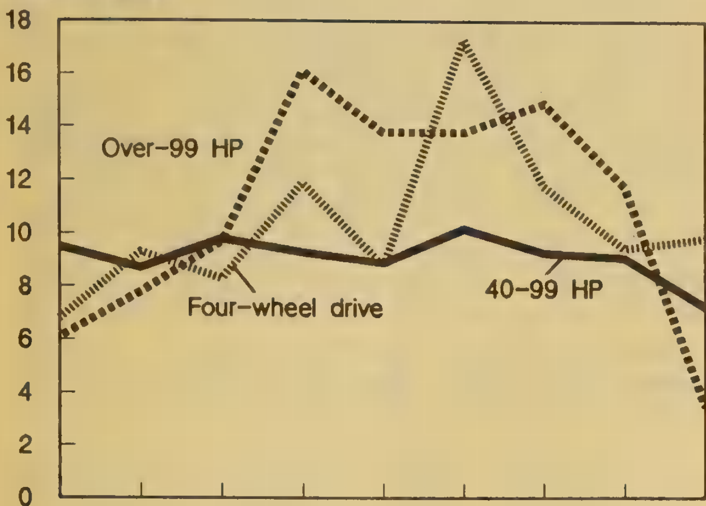
Inventories

Farm machinery inventories relative to sales were lower in April 1988 than a year earlier with the exception of four-wheel-drive tractors and small balers. The inventory-to-sales ratio for over-99 hp two-wheel-drive tractors showed the most significant decrease, falling from 11.8 in April 1987 to 3.5 in April 1988.

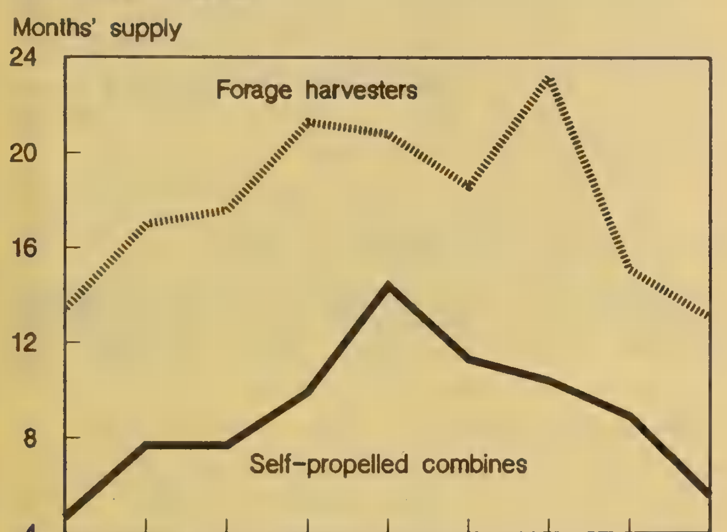
During most of the 1980's, manufacturers have been attempting to reduce inventories of most machinery to their traditional 6- to 8-month supply. April 1988 inventories of over-99 hp two-wheel-drive tractors represented a 3.5-month supply---less than a third of the 11.8-month supply registered in April 1987. Sales incentives on these units helped reduce inventories and increased the 12-month average sales rate by 50 percent. Because the April inventory-to-sales ratio is measured by dividing the average May through April (inclusive) monthly sales by April inventories, the boost in the sales rate helps lower the ratio. Nevertheless, April 1988 inventories represent 45 percent of April 1987 inventories.

April Farm Machinery Inventories

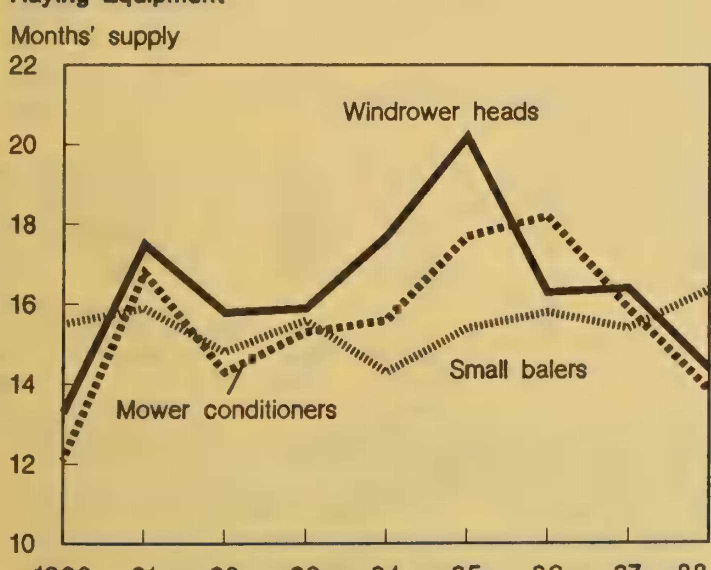
Farm Wheel Tractors



Harvesting Equipment



Haying Equipment



As of April 1988, inventories of 40-99 hp two-wheel-drive tractors and combines represented a 7- and 6-month supply, respectively. Inventories of windrowers, mower conditioners, balers, and forage harvesters exceeded a 13-month supply. With increased sales expected for all types of farm machinery, production rates are not likely to increase for the higher inventory items, but will probably increase for larger, two-wheel-drive tractors.

Trade

Farm machinery exports and imports in the first quarter of 1988 were up 38 and 33 percent, respectively, from the same period in 1987 (table 4). However, because imports exceed exports, the farm machinery trade deficit increased from $105 million to $122 million. Net farm machinery trade for all of 1987 saw imports exceed exports by $255 million, up from $164 million in 1986.

Exports to Western Europe grew 148 percent from first-quarter 1987 to

Table 4.—Farm machinery trade situation 1/

Trade/area	January-March 1986	January-March 1987	January-March 1988	Change 1987-88
	Million dollars			Percent
Exports to:				
Africa	18.0	15.2	16.6	9
Australia	13.7	8.6	18.2	112
Canada	192.5	161.4	165.6	3
Central America 2/	0.8	9.6	18.4	92
Eastern Europe	3.3	5.2	4.8	-8
Far East	10.7	11.5	24.0	109
Mexico	26.3	14.3	17.6	23
Middle East	3.7	3.6	2.2	45
Near East	2.4	2.9	5.2	80
Oceania	0.8	0.7	0.5	-33
Saudi Arabia	11.4	16.7	22.2	33
South America	25.1	35.7	31.7	-11
Western Europe	86.0	58.3	144.4	148
Total	404.7	343.7	473.1	38
Imports from:				
Africa	0.2	0.6	0.0	-95
Canada	76.1	109.2	162.4	49
Central America 3/	1.5	2.2	0.4	-82
Eastern Europe	7.9	4.5	11.3	152
Far East 4/	3.4	5.0	8.0	59
Japan	131.6	132.5	108.8	-18
Middle East	2.9	2.6	0.3	-87
Near East	0.3	0.1	4.7	8
Oceania	3.1	4.4	0.8	-78
South America	3.5	3.7	97.1	81
Western Europe 5/	49.2	46.7	61.9	33
Italy	30.5	29.3	44.2	51
United Kingdom	61.9	53.6	97.1	81
Germany	78.5	54.3	78.3	44
Total	450.6	448.7	594.8	33
Trade balance 6/	-45.9	-105.0	-121.7	-16

1/ Includes finished machinery items, nonassembled machinery, and parts. 2/ Includes Caribbean countries. 3/ Includes Caribbean countries and Mexico. 4/ Excludes Japan. 5/ Excluding Italy, the United Kingdom, and West Germany. 6/ May not add due to rounding of country export and import totals.

Source: U.S. Department of Commerce, Trade Development, Office of Special Industrial Machinery.

first-quarter 1988. Imports from Western European grew 53 percent. The fall in the dollar's value relative to European currencies increases the cost of imports. Thus, the rise in the value of farm machinery imports from Europe may be due more to the loss in the dollar's purchasing power than an increase in the quantity of imported goods.

Production of some mid-sized (40-99 hp) tractors has recently (or is planned to be) returned to the United States. The return could signal an end to the 1980's trend toward greater imports of European and Japanese tractors. The increased value of the U.S. dollar relative to the Euro-dollar and the Japanese yen and the apparent improvement in the U.S. farm economy has encouraged manufacturers to increase U.S. farm machinery production and capacity.

Tractor Use

The majority of acres in corn, soybean, cotton, and sorghum production are tilled by tractors of less than 160 hp (table 5). The under-100 hp tractors remain popular for planting crops given the lower power requirement for planting and that smaller tractors reduce soil compaction. In corn, soybean, and sorghum plantings, 28, 34, and 33 percent of the acres were planted with tractors of under 100 hp. Cotton acres have the smallest portion of tillage performed by under-100 hp tractors, perhaps reflecting farmers' efforts to reduce the time spent in the extensive tillage used in cotton production. The production of wheat in the dryer land areas with larger, more level fields increases the potential tractor size usable in wheat production. Thus, over-200 hp tractors are used most commonly in wheat production.

The smaller hp tractors tend to show a higher average age. This tractor age distribution reflects the more recent introduction of the higher hp tractors. There were no tractors of 100-140 hp available before 1960 and only a few models were offered before 1975. Tractors of over-140 hp were introduced even later.

Table 5.--Tractor use and average age by horsepower class in tillage and planting for 1987 1/

Horsepower	Wheat 2/ Percent of acres	Wheat 2/ Mean age 3/	Corn Percent of acres	Corn Mean age	Soybeans Percent of acres	Soybeans Mean age	Cotton Percent of acres	Cotton Mean age	Grain sorghum Percent of acres	Grain sorghum Mean age
					Tillage					
40-99	9	18	8	18	10	17	4	16	12	18
100-119	5	12	8	14	5	14	6	11	9	13
120-139	15	11	20	11	19	11	32	10	21	11
140-159	20	11	20	10	18	10	17	8	14	11
160-179	8	9	14	9	16	9	22	7	17	9
180-199	12	8	10	9	13	8	11	7	12	8
200-249	20	8	10	9	8	9	4	9	3	8
250-299	5	8	5	9	4	8	3	7	4	8
300 and over	6	7	5	7	6	8	*	*	8	7
Total 4/	5/ 99	10	100	11	100	10	99	8	100	11
					Planting					
40-99	16	19	28	19	34	18	9	15	33	18
100-119	8	13	15	14	14	14	9	12	13	14
120-139	18	11	22	11	21	11	42	10	21	10
140-159	18	11	18	10	13	9	16	8	11	10
160-179	7	9	5	8	9	8	14	7	8	9
180-199	10	8	5	9	5	7	7	7	11	8
200-249	12	9	5	7	3	8	2	5	*	*
250-299	3	8	*	*	*	*	**	**	**	**
300 and over	3	11	**	**	*	*	**	**	**	**
Total	96	12	99	13	99	13	100	9	98	13

* = Value included in previous horsepower range. ** = Statistically insignificant.

1/ Surveyed States for each crop are listed in Tables 6,8,9,10, and 11. 2/ Includes winter, spring, and durum wheat. 3/ Mean age weighted by acres worked. 4/ Represents all tractors in the above horsepower classes. 5/ May not add to 100 due to rounding or use of under 40 horsepower tractors.

The tractor age distributions indicate that tractors stay in service for a significant period of time. The average tractor age on acres tilled by 40–99 hp tractors ranges from 16 to 19 years. The average age of tractors on acres tilled by 200–250 hp tractors ranges from 8 to 9 years. Because tractors of 200–250 hp only came into significant production less than 20 years ago, the 8 to 9 year range indicates that many of these tractors remain in operation for extended periods of time.

Tillage

Planting directly into the residue of the previous crop (no–till) decreases the time and energy required for tillage. No–till planting maximizes crop residue cover which helps decrease soil erosion and soil moisture loss. However, crop residue can increase problems with weeds and pests and may lead to greater use of agricultural chemicals.

Use of a moldboard plow (one method of conventional tillage) turns the top of the soil under 6–10 inches. All crop residue is buried and considerable power is required for this operation. Early in this century, the moldboard plow was the primary tillage implement in use.

The degree to which farmers have moved away from use of the moldboard plow and into no–till and other tillage methods is shown in tables 6–11. Tillage methods reflect soil type, crop rotations, precipitation characteristics, and farmers' awareness of production advantages/disadvantages of changing tillage practices.

The moldboard plow is used on less than half the acres in wheat, corn, soybeans, cotton, and grain sorghum in all States except in Arizona cotton production. The portion of acres tilled with a moldboard plow varies across States and crops. The moldboard plow is used extensively in spring wheat production on the heavy clay soils of the Red River Valley in Minnesota and North Dakota. The significant use of the moldboard plow in corn production in the Lake States likely reflects corn following pasture or hay. Use of the moldboard plow tends to be greater in soybean production than corn due, in part, to corn–soybean rotations. Grain sorghum, wheat, and cotton tend to have a smaller portion of their acres moldboard plowed.

Tillage systems that do not include use of the moldboard plow and are not no–till systems commonly involve one or more of the following: heavy tandem disk, chisel plow, field cultivator, harrow, and disks of various sizes. Crop residue remaining can vary from virtually no residue to 90 percent, depending on the type of tillage implement(s) used, the number of times over, and the sequence of tillage passes.

No–till planting is done on less than 10 percent of the acres in most States. The greatest portion of no–till acres appears in

Table 6.--Tillage practices used in winter wheat production, 1987

Category	AR	CA	CO	ID	IL	IN	KS	MO	MT	NE	OH	OK	OR	TX	WA	Area
								Percent of acres 1/								
Tillage:																
Conv/w mbd plow 2/	*	9	4	15	4	10	23	22	3	13	9	25	44	2	6	15
Other systems 3/	95	91	96	80	94	85	77	78	94	86	82	75	54	97	90	84
No-till 4/	3	*	*	5	2	5	*	*	3	*	9	*	2	*	4	*
								Number								
Times over field:																
Conv/w mbd plow	na	5	6	7	4	4	6	4	6	5	3	6	5	5	6	5
Other systems	4	4	5	4	3	3	6	3	5	5	3	6	6	5	6	5
Hours per acre:																
Conv/w mbd plow	na	.66	.74	.43	.47	.59	.47	.67	.44	.60	1.2	.52	.42	.99	.43	.58
Other systems	.19	.40	.20	.33	.24	.33	.28	.21	.13	.33	.38	.30	.28	.23	.24	.26

* = less than 2 percent reported. na = not applicable.

1/ May not add to 100 due to rounding. 2/ Conventional with moldboard plow -- all tillage systems that include the use of a moldboard plow. 3/ Any tillage systems that does not include use a moldboard plow and is not a no-till system. 4/ No-till systems have no tillage operations performed prior to planting.

Table 7.—Tillage practice used in spring and durum wheat production, 1987

Category	Spring						Durum
	ID	MN	MT	ND	SD	Area	ND
	Percent of acres 1/						
Tillage:							
Conv/w mbd plow 2/	37	42	*	17	21	19	12
Other systems 3/	61	58	100	82	79	80	86
No-till 4/	2	*	*	2	*	*	2
	Number						
Times over field:							
Conv/w mbd plow	4	5	na	4	3	3	6
Other systems	4	4	5	5	3	4	5
Hours per acre:							
Conv/w mbd plow	.61	.41	na	.35	.42	.31	.29
Other systems	.50	.26	.14	.20	.21	.21	.15

* = Less than 2 percent reported. na = not applicable.

1/ May not add to 100 due to rounding. 2/ Conventional with moldboard plow -- all tillage systems that include the use of a moldboard plow. 3/ Any tillage systems that does not include use a moldboard plow and is not a no-till system. 4/ No-till systems have no tillage operations performed prior to planting.

Table 8.—Tillage practices used in corn production, 1987

Category	IL	IN	IA	MI	MN	MO	NE	OH	SD	WI	Area
	Percent of acres 1/										
Tillage:											
Conv/w mbd plow 2/	8	29	12	40	33	9	4	43	24	65	21
Other systems 3/	87	61	85	53	65	86	93	44	74	33	75
No-till 4/	5	10	3	7	2	4	3	13	2	2	5
	Number										
Times over field:											
Conv/w mbd plow	3	3	3	3	3	4	3	3	3	3	3
Other systems	2	3	2	2	2	3	2	3	3	3	2
Hours per acre:											
Conv/w mbd plow	.42	.40	.50	.48	.49	.57	.54	.46	.45	.55	.48
Other systems	.19	.26	.20	.27	.21	.27	.18	.27	.19	.33	.22

* = less than 2 percent reported.

1/ May not add to 100 due to rounding. 2/ Conventional with moldboard plow -- all tillage systems that include the use of a moldboard plow. 3/ Any tillage systems that does not include use a moldboard plow and is not a no-till system. 4/ No-till systems have no tillage operations performed prior to planting.

Table 9.--Tillage practices used in soybean production, 1987

Category	AL	AR	GA	IL	IN	IA	KY	LA	MN	MS	MO	NE	NC	OH	TN	Area
	Percent of acres 1/															
Tillage:																
Conv/w mbd plow 2/	15	*	12	31	33	20	17	*	44	*	5	9	8	47	16	22
Other systems 3/	84	98	87	67	62	78	65	97	55	95	95	91	84	49	80	75
No-till 4/	*	*	*	3	6	2	18	3	*	5	*	*	8	4	4	3
	Number															
Times over field:																
Conv/w mbd plow	3	na	4	3	3	4	4	na	4	na	3	3	3	4	4	3
Other systems	4	4	3	4	3	3	3	3	3	4	3	3	3	3	4	3
Hours per acre:																
Conv/w mbd plow	.55	na	.59	.37	.42	.41	.54	na	.48	na	.38	.38	.64	.56	.53	.40
Other systems	.43	.21	.18	.26	.28	.20	.28	.17	.25	.24	.26	.16	.25	.32	.28	.25

* = Less than 2 percent reported. na = not applicable.

1/ May not add to 100 due to rounding. 2/ Conventional with moldboard plow -- all tillage systems that include the use of a moldboard plow. 3/ Any tillage systems that does not include use a moldboard plow and is not a no-till system. 4/ No-till systems have no tillage operations performed prior to planting.

Table 10.--Tillage practices used in cotton production, 1987

Category	AZ	AR	CA	LA	MS	TX	Area
	Percent of acres 1/						
Tillage:							
Conv/w mbd plow 2/	50	*	7	3	3	18	13
Other systems 3/	42	99	93	97	97	81	86
No-till 4/	*	*	*	*	*	*	*
	Number						
Times over field:							
Conv/w mbd plow	5	na	8	6	5	5	6
Other systems	5	5	6	5	5	5	5
Hours per acre:							
Conv/w mbd plow	.90	na	.98	.32	.62	.56	.61
Other systems	.50	.34	.69	.36	.47	.40	.45

* = Less than 2 percent reported. na = not applicable.

1/ May not add to 100 due to rounding. 2/ Conventional with moldboard plow -- all tillage systems that include the use of a moldboard plow. 3/ Any tillage systems that does not include use a moldboard plow and is not a no-till system. 4/ No-till systems have no tillage operations performed prior to planting.

Table 11.--Tillage practices used in grain sorghum production, 1987

Category	KS	MO	NE	TX	Area
	Percent of acres 1/				
Tillage:					
Conv/w mbd plow 2/	5	5	3	7	5
Other systems 3/	94	94	92	93	93
No-till 4/	*	*	5	*	*
	Number				
Times over field:					
Conv/w mbd plow	4	4	4	4	4
Other systems	4	3	3	4	4
Hours per acre:					
Conv/w mbd plow	.50	.72	.75	.41	.53
Other systems	.20	.23	.22	.28	.23

* = Less than 2 percent reported.

1/ May not add to 100 due to rounding. 2/ Conventional with moldboard plow -- all tillage systems that include the use of a moldboard plow. 3/ Any tillage systems that does not include use a moldboard plow and is not a no-till system. 4/ No-till systems have no tillage operations performed prior to planting.

corn production, probably reflecting both the ease of planting corn in soybean residue and, because of higher precipitation, the greater need for reduced water erosion. The lowest portion of acres no-tilled are in spring wheat production. The greatest use of no-till in wheat and corn production is in Ohio, which may reflect Ohio's efforts to increase use of no-till.

Moldboard plowing increases the time a farmer spends tilling. The average time used in tillage systems using the moldboard plow is approximately one-half hour per acre. The average time used in other tillage methods is approximately one-fourth to one-third of an hour. Tillage time varies more significantly across States than across crops, reflecting differences in machine size, soil type, and climate.

ENERGY

U.S. farmers can expect energy prices to remain flat during the remainder of 1988, following an increase of close to 3 percent in the first half of the year. Although capacity constraints have led to tight supplies for some petroleum products in mid-1988, sharply lower crude oil prices in first-quarter 1988 and prospects for fundamentally weak oil markets through the end of the year should result in little, if any, increase in average petroleum product prices paid by farmers in 1988 than in 1987.

Earlier this year, farm energy expenditures were projected to slightly exceed last year's $6.9 billion due largely to a modest increase in corn acreage and a hefty increase in the areas planted to energy-intensive cotton and rice. Overall, these changes—coupled with only slightly higher energy prices and a modest reduction in total crop area—were expected to drive total energy expenditures up only slightly from last year's level. However, the impact of a prolonged and widespread drought, which would curtail some harvest operations as well as boost irrigation use in some regions, is likely to reduce energy expenditures 1-3 percent from previous expectations.

Oil Consumption and Production

OPEC's June agreement extended a 6-month old pact that set a production limit of 15.1 million barrels a day for the 12 nations that were parties to the agreement. Iraq refuses to accept its quota of less than 2.0 million barrels per day and currently produces 2.8 million barrels per day. Oil markets remain weak, with excess inventories, and continued production in excess of quotas that offset modest increases in world demand for crude oil. Increasingly, key OPEC members such as Kuwait and Saudi Arabia are investing in gasoline production and overseas marketing operations, circumventing their assigned quotas which apply only to crude oil.

Boosted by higher transportation activity, greater chemical production, and a cold first quarter in 1988, U.S. petroleum demand is projected to rise 1.8 percent in 1988, continuing the steady increases since 1985 (table 12). U.S. refiners paid $15.45 per barrel for crude oil in first-quarter 1988, off 14 percent from the previous quarter. Crude oil prices are expected to range from $15 to $18 per barrel during 1988.

Table 12.--U.S. petroleum consumption-supply balance

Item	1985	1986	1987	Forecast 1988
	Million barrels per day			
Consumption:				
Motor gasoline	6.83	7.03	7.18	7.29
Distillate fuel	2.87	2.91	2.96	3.04
Residual fuel	1.20	1.42	1.25	1.22
Other petroleum 1/	4.83	4.92	5.17	5.12
Total	15.73	16.28	16.56	16.85
Supply:				
Production 2/	11.26	10.96	10.63	10.52
Net imports (excludes SPR)	4.17	5.38	5.70	6.22
Net stock withdrawals	0.22	-0.21	0.09	0.01
Total	15.65	16.28	16.55	16.85
Net imports as a share of total supply	27	33	34	38
	Percent change from previous years			
Consumption		2.6	1.7	1.8
Production		-2.7	-3.0	-1.7
Imports		29.0	6.0	9.1

SPR = Strategic Petroleum Reserve April 1988 projections

1/ Includes crude oil product supplied, natural gas liquid (NGL), other hydrocarbons and alcohol, and jet fuel. 2/ Includes domestic oil production, NGL, and other petroleum products.

Source: U.S. Department of Energy. Energy Information Administration. Short-Term Energy Outlook, DOE/EIA-0202 (88/2Q). April 1988.

Although domestic production of crude oil and natural gas liquids is expected to slacken by 110,000 barrels per day in 1988, the drop is far less than the decline of 330,000 barrels per day registered in 1987. Alaskan production is expected to begin declining next year, adding to current decreases in domestic production. Expanding demand, combined with falling domestic production, may cause imports (excluding imports for the Strategic Petroleum Reserve) to rise 12 percent to 6.3 million barrels per day in 1988. Net imports are expected to account for 38 percent of petroleum supplies in 1988.

Energy in the Farm Sector

The energy supply and price outlook for U.S. agriculture largely reflects world market conditions, which are characterized by abundant oil supplies and relatively low prices. In 1988, farmers can expect plentiful supplies of diesel fuel, gasoline, and LP gas at slightly lower prices than last year.

Farm Fuel Use

Gasoline and diesel fuel use declined in recent years due to adoption of energy-saving farm production technologies, shifts from gasoline to more efficient diesel-powered units, and reduced planted acreage. Continued replacement of older gasoline machines by diesel-powered machines, particularly in the production of cotton, rice, and some minor crops, is responsible for higher use of diesel relative to gasoline (table 13). In 1987, although total fuel use declined, with sharp drops in LP gas and gasoline of 14.3 and 11.8 percent, respectively, diesel fuel use increased 3.5 percent due to the replacement of gasoline-powered machines with diesel. Estimated natural gas consumption declined more than 10 percent because of a decrease in irrigated areas depending on natural gas.

Energy Expenditures Flat in 1987

In 1987 farm energy (gasoline, diesel fuel, LP gas, and electricity) expenditures were $6.9 billion, the same as 1986 (table 14). Savings resulting from reduced acreage in 1987 were offset by higher petroleum prices. Energy expenditures in 1988 were expected to inch up 1.5 percent from last year, but the drought now is expected to reduce expenditures from previous expectations.

Table 13.--Farm fuel use

Year	Gasoline	Diesel	LP gas	Natural gas 1/
	Billion gallons			Billion cubic feet
1978	3.6	3.2	1.3	147
1979	3.4	3.2	1.1	125
1980	3.0	3.2	1.1	93
1981	2.7	3.1	1.0	83
1982	2.4	2.9	1.1	83
1983	2.3	3.0	.9	71
1984	2.1	3.0	.9	68
1985	1.9	2.9	.9	50
1986	1.7	2.9	.7	58
1987	1.5	3.0	.6	54

1/ Personal Communication, U.S. Department of Agriculture, Office of Energy, Washington, D.C., July 1988.

Table 14.--Farm energy expenditures

Item	1985	1986	Preliminary 1987	1988 Forecast 1/ Initial	Scenario 1	Scenario 2
	Billion dollars					
Fuels and oil	6.6	4.8	4.4	4.5	4.4	4.3
Electricity	2.2	2.1	2.5	2.5	2.5	2.5
Total	8.8	6.9	6.9	7.0	6.9	6.8
Percent change from preceding year		-22.0	0.0	1.5	-1.0	-3.0

1/ The first scenario represents normal weather after July 4 and the second scenario represents continued dry weather conditions.

Energy Prices Up Only Slightly in 1988

Farm fuel prices in 1987, in response to moderate world oil price movements, rose only slightly and remained below those of 2 years ago. Gasoline and diesel fuel prices went up 3 percent from 1986, while LP gas prices decreased 12 percent. Farmers paid an average of $0.92 a gallon for bulk-delivered gasoline and $0.71 a gallon for diesel fuel, and $0.59 a gallon for LP gas (table 15).

In 1988, farm fuel prices are expected to rise only lightly from 1987 levels. USDA's July 1988 index of fuel energy prices stood at 166 (1977=100), up 3 percent since January, but only 0.5 percent from a year earlier.

Table 15.—Average U.S. farm fuel prices 1/

Year	Gasoline	Diesel	LP gas
	Dollar per gallon 2/		
1979	0.80	0.68	0.44
1980	1.15	.99	.62
1981	1.29	1.16	.70
1982	1.23	1.11	.71
1983	1.18	1.00	.77
1984	1.16	1.00	.76
1985	1.15	.97	.73
1986	.89	.69	.67
1987	.92	.71	.59
1988			
January	.90	.73	.60
April	.91	.75	.60
July	.95	.75	.58

1/ Derived from surveys of farm supply dealers conducted by the National Agricultural Statistics Service, USDA. 2/ Bulk delivered.

Drought and Energy Use In U.S. Agriculture

The 1988 drought will lower overall energy expenditures in U.S. agriculture 1-3 percent from the previous forecast of about $7.0 billion (table 14). The extent of the reduction in energy use depends upon assumptions regarding future weather conditions. If the drought ends now and weather through the rest of the year is normal, energy expenditures will be 1-2 percent below earlier forecasts. If dry conditions continue, energy expenditures could fall an additional 1-2 percent.

About 65 percent of aggregate U.S. agricultural energy expenditures is for energy consumed directly for tilling the soil and planting, and miscellaneous crop and livestock operations. The bulk of these expenditures already has been incurred in 1988. Most of the remaining 35 percent will be expended for irrigation and harvest operations. Thus, any reductions in energy expenditures for the remainder of the year are related primarily to smaller quantities of commodities to harvest, transport, and dry. Some costs, such as drying, likely can be reduced one for one with a smaller-than normal harvest, but savings in most other harvesting operations aren't likely to be proportional to the reduction in size of harvest. To some extent, reductions in harvesting expenditures will be offset by increased irrigation expenditures.

Table 16.—Energy use by selected farm activities in the Corn Belt, Lake States, and Northern Plains, 1981

Activity	Gasoline	Diesel	LP gas	Natural gas	Electricity
			Percent 1/		
Harvesting	54	55	38	—	—
Farm truck	55	—	—	—	—
Drying	—	—	68	91	61
Irrigation	17	49	48	24	16
Total 2/	52	40	52	33	38

1/ Regions' share relative to U.S. total for each activity and energy source. For example, of the total gasoline used for harvesting in the U.S., 54 percent was used in the three regions. Of the total diesel used for harvesting, 55 percent was used in three regions. 2/ Includes all crop and livestock activities for each energy source.

Source: U.S. Department of Agriculture. Economic Research Service. Energy and U.S. Agriculture: State and National Fuel Use Tables, 1978, 1980, 1981. Washington, D. C., 1987.

The major regions currently affected by the drought--the Corn Belt (Illinois, Indiana, Iowa, Missouri, and Ohio), the Lake States (Minnesota, Michigan, and Wisconsin) and the Northern Plains (Kansas, Nebraska, North Dakota, and South Dakota) ordinarily produce about 85 percent of the U.S corn crop, 80 percent of the soybeans, and 60 percent of the wheat. States in these regions consume about 50 percent of all gasoline, diesel, and LP gas (over 2.5 billion gallons) and 33 percent of all natural gas (20 billion cubic feet) used on farms (tables 13 and 16). Also, nearly 40 percent (about 14 billion kwh) of all farm electricity is consumed in these regions.

The drought also has affected the Pacific and Mountain States and parts of Kentucky, Tennessee, Oklahoma, and Texas. However, many crops in most of these States normally are irrigated and the drought will have less effect on crop yields but may increase expenditures for irrigating.

This fall some crop area likely will not be harvested, and with reduced yields, fuel consumption for combining, transportation, and drying will be reduced. Other activities, such as wind erosion prevention, are likely to result in only minor increases in fuel use. Harvest operations in the entire United States account, on average, for an estimated 14.7 percent, or 750 million gallons, of total farm fuel use. By fuel type this amounts to 15.1 percent of the gasoline consumed in U.S. agricultural production, 17.0 percent of the diesel, and 6.1 percent of the LP gas (table 17). Drying accounts for only 6.3 percent of

Table 17.--Estimated energy consumption by U.S. farmers, 1981

Farm operation	Gasoline	Diesel	LP gas	Gasoline, diesel, and LP gas	Natural gas	Electricity
				Percent		
Preplant, plant, and cultivate	2.6	56.9	1.4	26.3	---	---
Fertilizer and pesticide applications	1.5	5.2	.1	3.0	---	---
Harvesting	15.1	17.0	6.1	14.7	---	---
Farm truck	15.1	---	---	6.3	---	---
Drying	---	---	44.5	6.3	13.5	2.8
Irrigation	2.1	3.9	12.8	4.4	71.9	43.0
Other crop operations	45.6	1.9	2.2	20.2	3.6	9.8
Livestock	18.0	15.1	32.9	11.0	18.8	44.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: U.S. Department of Agriculture. Economic Research Service. Energy and U.S. Agriculture: State and National Fuel Use Tables, 1978, 1980, 1981. Washington, D.C., 1987.

total fuel consumption, but about 45 percent of total LP gas consumption.

The influence of the drought on energy expenditures is examined for two weather scenarios. The first scenario, with normal weather from July 4 to the end of the crop season, implies an aggregate reduction of 25 percent in the production of corn, soybeans, and wheat. The other scenario, which assumes dry conditions will continue, suggests a 33-percent drop in production for these crops.

A 25- to 33-percent reduction in crop size is estimated to result in a decrease of 3.0 to 4.0 percent in gasoline, 2.3 to 3.1 percent in diesel fuel, 7.9 to 10.5 percent in LP gas, 3.1 to 4.0 percent in natural gas, and 0.04 to 0.06 percent in electricity consumption from original projections (see table 18). Given expected prices of $.89 per gallon for gasoline, $.69 per gallon for diesel fuel, $.60 per gallon for LP gas, $3.68 per 1,000 cubic feet for natural gas, and $0.07 cents per kwh for electricity, the total reduction in expenditures amounts to $130 to $180 million.

However, in some areas, fuel consumption could be increased by drought. In Nebraska, for example, increases in irrigation and fuel

Table 18.--Estimated energy use in harvesting, transporting, drying, and irrigating in the Corn Belt, Lake States, and Northern Plains, 1988 1/

Activity	Gasoline	Diesel	LP gas	Natural gas	Electricity 2/
	Million gallons			Million cubic feet	Million kwh
Harvesting	120	280	10	---	---
Farm truck 3/	60	---	---	---	---
Drying	---	---	180	6,600	600
Irrigation 4/	2	37	28	9,000	[illegible]
Total 5/	780	1,440	310	17,820	13,300

1/ With the exception of electricity, quantities computed from tables 13, 16, and 17. For example, the estimated consumption of gasoline of 130 million gallons used in harvesting in the Corn Belt, Lake States and Northern Plains in 1987 is computed by multiplying aggregate gasoline consumption in 1987 (table 13) by the proportion used in harvesting (table 17) by the proportion used in these regions (table 16). 2/ Aggregate consumption of electricity in 1987 is assumed to be 35 billion kwh. 3/ Assumes 50 percent of consumption at harvest. 4/ Nebraska only. 5/ Includes livestock.

consumption are likely to be substantial because the irrigation season started earlier than normal and more applications will have to be made during the season. Extension specialists report that irrigation expenditures in Nebraska will increase by up to 20 percent, amounting to more than $30 million in additional expenditures on fuel and electricity.

Other areas could have changes in energy expenditures on cropping or livestock activities as a result of drought. However, in these areas changes in expenditures on cropping activities are not expected to be significant because irrigation is a common practice, crops are already established, or irrigation is not economical given low water tables.

SEEDS

Consumption

In 1988, total seed use for major field crops is expected to be nearly 6 million tons, up less than 1 percent from 1987 (table 19). Rice and cotton will be primarily responsible for the increase, as planted acreage of these crops was up 22 and 14 percent, respectively. Seed use also increased for corn, soybeans, and wheat, but only moderately--3 percent for corn, 2 percent for soybeans, and 1 percent for wheat. The increases were nearly offset by reduced seed use for oats, barley, and grain sorghum as planted acreage fell 22, 12, and 11 percent, respectively.

Prices

Between 1987 and 1988, seed prices paid by farmers decreased 1 percent each for corn and cotton, and 10 percent for potatoes. However prices for sorghum, oats, wheat, and soybeans increased 3, 10, 6, and 5 percent, respectively, from 1987 (table 20). Changes in seed prices paid by farmers partly reflect corresponding changes in prices of the respective commodities. U.S. demand for forage seeds, particularly grass seeds, soared in recent years due to the Conservation Reserve Program (CRP) which was enacted under the Food Security Act of 1985. Under this program, farmers receive support payments for taking highly erodible acreage out of production and seeding it to either grass or trees. In 1987, grass seed prices jumped, as over 13 million acres were taken out of crop production and placed into grass and trees under the CRP. In 1988, many grass prices increased further, as over 8 million additional CRP acres have been seeded thus far this year. The CRP goal is 45 million acres in 1990. Although either trees or grasses can be planted on CRP acreage, grasses are used on more than 80 percent of such land.

The rapidly expanding demand for grass seeds has led to sharp increases from a year earlier in the price of timothy, ryegrass, and orchardgrass seeds. The increase ranged from 1 percent for orchardgrass seed to 23 percent for timothy grass seeds. Compared with 1985, when the CRP was initiated, prices of different types of forage seeds have recorded

Table 19.--Seed use for major U.S. field crops

Crops	1981	1982	1983	1984	1985	1986	1987	1988 1/	Change 87-88
	Thousand tons								Percent
Corn	566	543	406	535	594	546	465	482	3
Grain sorghum	56	56	50	64	56	48	45	39	-13
Soybeans	1,926	2,019	1,818	1,932	1,800	1,770	1,653	1,684	2
Barley	317	319	418	468	518	514	430	377	-12
Oats	528	566	693	510	554	614	504	464	-8
Wheat 2/	3,390	3,300	2,910	3,000	2,940	2,790	2,520	2,550	1
Rice	255	220	160	165	140	130	130	159	22
Cotton	140	103	74	102	97	92	93	106	14
Total	7,178	7,198	6,529	6,776	6,699	6,504	5,843	5,861	*

* = Less than 1 percent.

1/ Based on June 1, 1988 planted acreage. 2/ Includes winter wheat seed used the previous fall.

Table 20.--Prices paid by farmers for selected planting seeds 1/

Item	Unit	1985	1986	1987	1988	Change 86-87	Change 87-88
		Dollars				Percent	
Field seeds:							
Corn	3/	4/ 67.30	66.00	64.90	64.20	-1	-1
Grain sorghum	Cwt	66.10	67.00	63.60	65.70	-6	3
Oats	Bu	4.18	3.63	3.99	4.37	10	10
Barley	Bu	5.10	4.82	4.47	4.58	-7	1
Wheat	Bu	6.10	6.00	5.56	5.89	-6	6
Soybeans	Bu	11.90	11.00	11.30	11.90	[illegible]	5
Cotton	Cwt	48.20	47.00	48.10	47.70	3	-1
Potatoes	Cwt	8.06	6.62	7.95	7.12	20	-10
Forage seeds:							
Red clover	Cwt	121.00	133.00	160.00	143.00	20	-11
Fescue 2/	Cwt	53.10	67.00	107.00	71.80	60	-33
Orchardgrass	Cwt	80.90	87.00	115.00	116.00	32	1
Ryegrass, annual	Cwt	37.30	36.00	45.10	47.90	25	6
Timothy	Cwt	58.80	78.00	107.00	132.00	37	23
Lespedeza, sericea	Cwt	210.00	193.00	233.00	275.00	21	18
Alfalfa, certified	Cwt	219.00	219.00	222.00	245.00	1	10

1/ Derived from, the April survey of farm supply dealers conducted by the National Agricultural Statistics Service, USDA. 2/ Tall, alta and Kentucky 31. 3/ 80,000 kernels. 4/ Estimated.

Table 21.--U.S.farm expenditures for seeds 1/

Item	1981 2/	1982	1983	1984	1985	1986	1987	Change 86-87
	Billion dollars							Percent
Field crops and small grains	2.83	2.61	2.44	3.21	3.17	2.70	2.45	-9
Legumes, grass, and forages	.38	.31	.41	.40	.37	.39	.39	0
Seeds and plants for other crops	.43	.50	.36	.37	.36	.37	.65	72
Other seed expenses 3/	.05	.03	.06	.05	.04	.04	.05	21
Total seed expenditures	3.93	3.71	3.49	4.28	3.94	3.50	3.54	1

1/ Excludes bedding plants, nursery stocks, and seed purchased for resale. 2/ For 1981-1983, landlord expenditures included in the total but not for individual items. For 1984-1987, landlord expenditures included in individual items and total. 3/ Includes seed treatment.

at least double-digit percentage increases. While most price increases are clustered around 30 percent, timothy seed showed the largest gain, at 124 percent above its 1985 price.

Seed Expenditures

In 1987, total farm seed expenditures increased only 1 percent from 1986 to $ 3.54 billion (table 21). However, seed expenditures for field crops and small grains fell 9 percent from 1986 to $2.5 billion, due to a reduction in planted acreage. Declines in field crops and small grains were offset by a 72-percent increase in seeds and plants for other crops and a 21-percent increase in other seed-related expenses. Farm seed expenditures are expected to rise 1 percent in 1988.

Trade

The U.S. trade surplus in seeds for planting declined 12 percent from 1986 to $228 million in calendar 1987 (table 22). By volume, the trade surplus decreased 8 percent from 181,000 metric tons in 1986 to 166,000 in 1987. The decline was largely attributable to the CRP. Acres enrolled in the CRP increased from 2 million in 1986 to 25.2 million so far in 1988. Domestic supplies were inadequate to meet the sudden expansion in demand from forage seeds, especially for grass seeds,

Table 22.--Total U.S. exports and imports of all seeds for planting

Item	1983	1984	1985	1986	1987	Change 86-87
	Million dollars					Percent
Value:						
Exports	329	320	358	371	374	8
Imports	84	90	87	113	146	29
Balance	245	230	271	258	228	-12
	Thousand metric tons					
Volume:						
Exports	228	222	236	240	249	4
Imports	48	45	43	59	83	41
Balance	180	177	193	181	166	-8

Table 23.--U.S. exports and imports of forage seed for planting

Item	1983	1984	1985	1986	1987	Change 86-87
	Million dollars					Percent
Value:						
Exports	65	70	59	74	75	1
Imports	34	17	18	39	65	67
Balance	31	53	41	35	10	-71
	Thousand metric tons					
Volume:						
Exports	51	56	41	64	49	-23
Imports	32	18	19	31	43	39
Balance	19	38	22	33	6	-82

causing prices and imports to surge. In 1987, the forage seed trade surplus declined 71 percent in value and 82 percent in volume (table 23).

U.S. imports of planting seed for calendar 1987 were valued at $145.5 million, up 29 percent from 1986, and 67 percent from 1985 (table 24). U.S. forage seed, especially grass seed, accounted for a large portion of the increase. All types of forage seed registered increases, although the sharpest rises were in orchardgrass, fescue, timothy, alfalfa, and bluegrass seeds. The value of total forage seed imports in 1987 jumped 69 percent from 1986, and rose nearly four-fold from calendar 1985. Vegetable and flower seed imports also increased in 1987, but only 18 and 15 percent, respectively. Corn seed imports, on the other hand, declined 42 percent in value after a 35-percent decline in 1986.

By volume, total seed imports increased 41 percent from a year earlier in calendar 1987. Imports in 1986 rose 37 percent from 1985, the year when the CRP was introduced (table 25). Increases were widely spread across all categories of forage seed with the sharpest percentage gains in fescue grass, orchardgrass, alfalfa, rye grass, and timothy. Vegetable seed imports by volume in 1987 and 1986 increased 7 and 40 percent, respectively, from 1986 and 1985. Corn seed imports declined 44 percent and 62 percent respectively, in 1987 and 1986.

Canada continued to be the leading supplier of seed for planting, accounting for $54.9 million in 1987, up nearly 40 percent from 1986. The Netherlands remained the second largest supplier with sales of $14.8 million in 1987, followed by Taiwan with sales of $9.8 million.

Canada is also our primary foreign source of forage seeds. In 1987, forage seed imports from Canada increased $18 million, a 59-percent jump from 1986. New Zealand, Australia, and the Netherlands held second, third, and fourth places, respectively.

Forage seed imports are likely to continue growing if enrollment goals for the CRP are to be met. Several foreign countries have expressed interest in increasing their production to meet the new U.S. demand. Undoubtedly, U.S. production of these seeds will increase and, to that extent, the rise in imports will be held in check. However the domestic industry has been reluctant to gear up to satisfy the extra demand for two reasons: 1) there is no guarantee that the CRP will be included in the next farm bill, and 2) once the extra CRP acres are seeded, their maintenance will require less seed.

Table 24.--Value of U.S. seed imports for planting

Item	1983	1984	1985	1986	1987	Change 86-87
	Thousand dollars					Percent
Forage:						
Bluegrass, NES	116	243	400	481	854	78
Bluegrass, Kent	53	437	1,376	938	1,534	64
Creeping red fescue	2,993	2,985	5,046	8,554	10,252	20
Meadow fescue	12	31	14	1	21	20
Orchardgrass	112	62	38	74	698	843
Fescue, NSPF	98	149	110	323	1,367	323
Ryegrass	156	156	646	2,974	8,229	177
Timothy	452	492	555	904	3,397	276
Clover, red	12,356	4,914	2,181	6,185	8,305	34
Alfalfa	1,489	689	568	823	2,765	236
Total	17,837	10,158	10,934	21,257	37,422	76
Other forage	16,362	6,397	7,057	17,372	27,997	61
Total forage	34,199	16,555	17,991	38,629	65,419	69
Vegetables	30,453	31,940	33,951	41,853	49,461	18
Flower	10,217	17,535	17,485	18,331	21,022	15
Corn 1/	5,939	22,289	14,045	9,118	5,283	-42
Trees/shrubs	893	1,089	1,394	1,401	1,342	-4
Other	2,109	465	2,021	3,580	3,004	-16
Total seed	83,810	89,873	86,887	112,912	145,531	29

1/ Certified corn.

Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division.

Table 25.--Volume of U.S. seed imports for planting

Item	1983	1984	1985	1986	1987	Change 86-87
	Metric tons					Percent
Forage:						
Bluegrass, NES	84	155	227	171	298	74
Bluegrass, Kent	50	302	753	404	496	23
Creeping red fescue	3,202	3,845	6,401	8,156	8,404	3
Meadow fescue	6	25	8	1	13	12
Orchardgrass	105	70	53	99	469	307
Fescue, NSPF	38	213	75	224	911	374
Ryegrass	147	129	943	3,210	8,526	166
Timothy	676	798	884	1,130	2,393	112
Clover, red	10,217	4,578	2,405	5,075	5,698	12
Alfalfa	928	358	269	379	1,192	215
Total	15,453	10,473	12,018	18,849	28,400	51
Other forage	16,547	7,527	6,982	12,151	14,600	20
Total forage	32,000	18,000	19,000	31,000	43,000	39
Vegetables	10,000	9,000	10,000	14,000	15,000	7
Flower	145	186	180	185	173	-6
Corn 1/	5,564	17,600	12,573	8,500	4,754	-44
Trees/shrubs	109	135	225	191	122	-36
Others	182	79	1,022	5,124	19,951	289
Total seed	48,000	45,000	43,000	59,000	83,000	41

1/ Certified corn.

Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division.

QUANTIFYING THE RELATIONSHIP BETWEEN COMMODITY PRICES AND SEED PRICES

by

Stan Daberkow and Mohinder Gill

Abstract: Seed prices for selected nonhybrid spring planted crops were found to be strongly linked to the underlying commodity price, lagged 1 year. A dummy variable, used to account for commodity program changes, improved the attributes of the equation. Hybrid corn and grain sorghum seed prices were weakly correlated with lagged commodity prices, but highly correlated with a time trend variable. Thiel's (U2) inequality coefficient indicated that, with the exception of cotton, the final equations were better predictors of future seed prices than simply using last year's seed price.

Keywords: Seed price, commodity price, forecast, hybrid seed, nonhybrid seed

Farmers spend between $3 and $4 billion annually for seed and plant materials. Expenditures are, of course, made up of prices and quantities, but each component is influenced by different factors. The quantity of seed used each year is heavily tied to planted acreage, since changes in seeding rates occur very slowly over time. Seed prices paid by farmers are influenced by a number of factors, but the prices received by farmers for the corresponding commodity are often a key factor. Hence, quantifying the relationship between seed prices and the underlying commodity should be useful in explaining seed price movements, as well as forecasting seed prices.

Prices paid by farmers for agricultural inputs are often influenced by the prices of the raw materials used to produce those inputs. Natural gas prices in ammonia production, crude oil prices in petroleum product production, phosphate rock and sulphur in phosphoric acid production, and steel prices in farm machinery production are examples of raw materials having a significant effect on the prices paid by farmers for manufactured inputs.

Depending on the input, other factors--such as labor, transportation and distribution, research and development costs, industry structure, and the strength of demand for the input--determine final agricultural input prices. But for many inputs, the final price is closely linked to the cost of raw materials, which in turn could be used as a predictor of input price.

Seed is another example where the prices paid by farmers tend to be correlated with the underlying raw material or agricultural commodity price. Seed production competes for the same resources as those used in commodity production. Hence, farmers weigh the returns from seed production against those from non-seed commodity production. Returns from non-seed production cannot diverge greatly from those derived from other commodity markets (or for some commodities, returns supported by Government programs).

Seed companies recognize this relationship and most seed production contracts with farmers tie the contract price for the seed to the underlying commodity market price plus a premium for any added costs for inputs, differences in yields, extra management skills, and different tillage and harvesting practices. Hence, we would expect seed companies to adjust their prices each year based partly on contract prices paid to seed producers.

Furthermore, some farmers are both producers and consumers of seed. For many crops, especially nonhybrids, farmers have the option of saving seeds from the previous year's crop; so they weigh the difference in cost. Often they use both strategies, allowing them

to hold down production costs and at the same time introduce new, more productive varieties into their variety rotation. Data for 1987 indicate 70 percent of soybean seed is purchased, 34 percent of barley seed, 40 percent of oats, 80 percent of potatoes, 50 percent of wheat, and 80 percent of cotton. Anecdotal evidence suggests that these percentages have been increasing since 1970.

Hybrid crops, such as corn and grain sorghum, pose a different set of circumstances, because seed saved from earlier harvest has characteristics significantly different from its parent. Hybrid varieties, therefore, typically will be purchased from seed companies each year. In addition, the expense of research and development associated with the development of a proprietary hybrid variety must be recovered through prices charged to farmers. Hence, we might expect that hybrid seed prices are only minimally affected by the underlying basic commodity price.

Model Construction

Preliminary examination of commodity and seed price data for 1969-87 for several crops indicated that seed price changes tend to follow commodity price changes with a 1-year lag. A regression model, with seed price as the dependent variable and commodity prices lagged one period as the independent variable was constructed as follows: $PS_t = a + bPC_{t-1} + e_t$. PS_t represents April seed prices in year t; PC_{t-1} represents commodity marketing year prices received by farmers for the previous year; a and b are estimated parameters and e is an error term. In other words, a linear relationship was hypothesized between a crop's April seed price and its commodity price in the previous marketing year.

Regression coefficients and associated statistics were estimated for eight spring planted crops: corn, grain sorghum, spring wheat, barley, oats, soybeans, potatoes, and cotton (table 26). Based on estimated

Table 26.--Non-hybrid seed price regressed on lagged commodity price and dummy variable

Crops	Constant	Coefficient		Statistic			1988 seed price			
		Commodity	Dummy	R squared	TPE	U2	Unit	Forecast 1/	Actual 2/	Difference
								Dollars		Percent
Soybeans	0.4577	1.74 (9.90)	-	0.86	2	0.48	Bu	10.06	11.90	-15
	0.0719	1.73 (11.94)	2.67 (2.72)	.91	0	.37	Bu	12.94	"	9
Barley	.1760	2.08 (13.18)	-	.92	1	.61	Bu	3.92	4.58	-14
	.0542	2.09 (16.97)	.66 (3.33)	.95	3	.43	Bu	4.35	"	-5
Oats	.4724	2.29 (11.19)	-	.89	4	.75	Bu	4.17	4.37	-5
	.4556	2.25 (12.04)	.41 (2.06)	.91	5	.66	Bu	4.74	"	8
Potatoes	-.0526	1.56 (17.68)	-	.95	2	.25	Cwt	5.76	7.12	-19
	-.0423	1.55 (16.66)	.07 (0.22)	.95	2	.25	Cwt	5.92	"	-17
Upland cotton	4.7218	.58 (5.15)	-	.63	5	1.99	Cwt	40.72	47.70	-15
	4.9327	.53 (6.84)	13.89 (4.46)	.84	6	1.29	Cwt	50.81	"	7
Spring wheat	1.2839	1.51 (5.72)	-	.67	3	0.30	Bu	4.96	5.89	-16
	.7903	1.59 (5.63)	.08 (-0.28)	.88	4	0.33	Bu	5.21	"	-12

Note: t-values in parentheses.

1/ Using 7 month (September 87-March 88) average price received by farmers for soybeans and potatoes; 10 month (June 87-March 88) average price for barley, oats and spring wheat; and 8 month (August 87-March 88) average price for upland cotton. 2/ April 1988 prices.

relationships between commodity and seed prices, April 1988 prices were forecast and compared with actual prices.

Results and Model Reformulation

With the exception of the two hybrid seed varieties, our initial model indicated a very strong relationship between a crop's commodity price and seed price. R-squares for the six nonhybrid crops ranged from .63 for cotton seed to .95 for potatoes, while the coefficients were highly significant for all crops. However, our sample forecasts for 1988 seed prices, based on our estimated equations, differed from actual prices by 5 percent to 19 percent. Oats was an exception, with the forecast price only 5 percent less than the actual 1988 price. Based on the poor 1988 forecasts with the exception of oats, the data were reviewed and the model reformulated. Differences between the forecast price and actual price were particularly large after 1983.

Two farm policy changes occurred after 1983 that may have led to a shift in the historical relationship between commodity prices and seed prices. First, Congress modified the 1981 commodity program legislation, by lowering the 1984/85 and 1985/86 loan rates (except cotton and soybeans) below 1983/84. Second, the Food Security Act of 1985 permitted the Secretary of Agriculture to lower farm program commodity loan rates, and in the case of cotton and rice, establish a marketing loan program. For all commodities, target prices, where they existed, were not reduced and thus continued to protect a farmer's income even though loan rates declined. However, target prices have been lowered for the 1988/89 crops. And beginning in April 1986, PIK certificates were issued to farmers for farm program crops, which essentially allow the commodity market price to fall substantially below the loan rate, yet enable farmers to realize at least loan rate prices for their program commodities.

To capture this structural shift in the commodity-seed price relation, a dummy variable was constructed with ones for the 1985, 1986, and 1987 crop years and zeroes elsewhere. For soybeans and cotton, a dummy variable with a one in 1987 and zero elsewhere was created to capture the effect of declining loan rates. The new reformulation of the model was $PS_t = a + bPC_{t-1} + cD_t + e_t$. Results indicate that little additional explanatory power was added by the dummy variable, except for cotton and spring wheat, but the forecasts for 1988 were improved, especially for barley.

The potato seed price equation again had a very high R-square and significant coefficients but our forecasts for 1988 were still disappointing. While potatoes are not covered by a commodity program, some substitution may occur between potatoes and program crops. Including the dummy variable in the potato equation did little to improve the 1988 forecasts. Forecasting spring wheat seed prices also proved troublesome, at least for 1988, which may be related to the low percentage (50 percent) of seed purchased each year. The structural change variable was insignificant and the 1988 forecast was off by 12 percent.

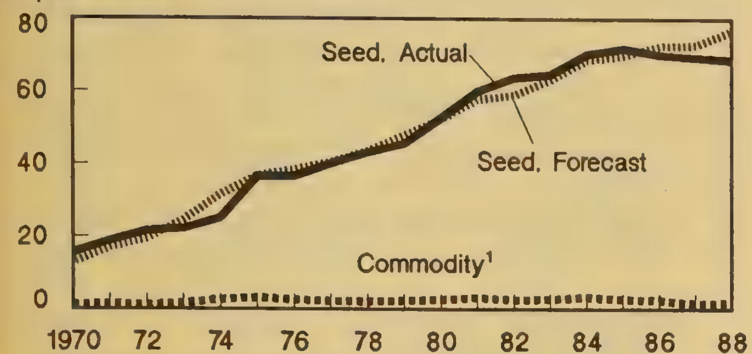
For hybrid corn and grain sorghum seed, commodity price was not closely linked to the price of crop seed (table 27). The original model explained only 35 to 27 percent of the variation in seed price. The model was reformulated by adding a time trend intended to capture the continually increasing price of hybrid seed not related to the underlying commodity price. In mathematical terms, $PS_t = a + bPC_{t-1} + cT + e$ where T is a simple time trend and c is an estimated coefficient. The time trend may represent the increasing development, production, and marketing costs associated with new hybrid varieties that were passed on to farmers.

Commodity prices, coupled with the time trend, provided a close fit with R^2 above .95 in both cases. In the corn equation, both the price and time trend coefficient were highly significant, while for sorghum only the time trend coefficient was highly significant. The commodity price coefficient for sorghum had the expected sign, but was not highly significant. Using these equations, prices for 1988 were forecast and were found to be within 12 and 9 percent of the actual corn and sorghum seed price, respectively. Experimentation with the same structural change variable used in the nonhybrid seed analysis did not greatly improve the 1988 forecasts.

U.S. Commodity and Seed Prices

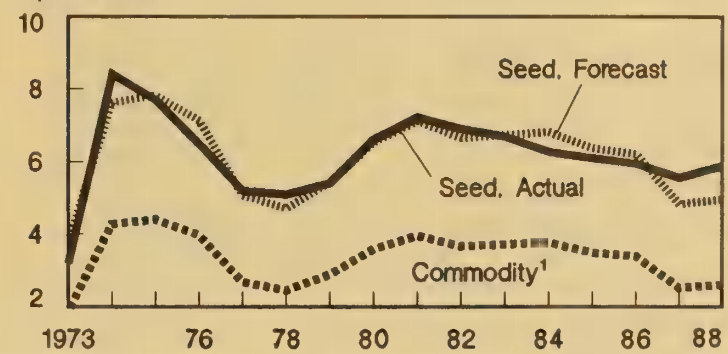
Corn

$ per bushel



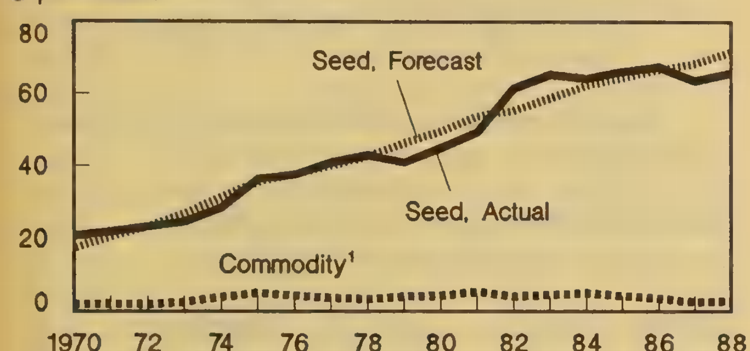
Spring Wheat

$ per bushel



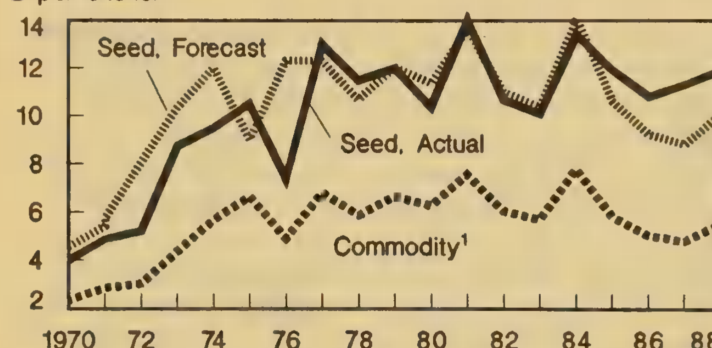
Grain Sorghum

$ per bushel



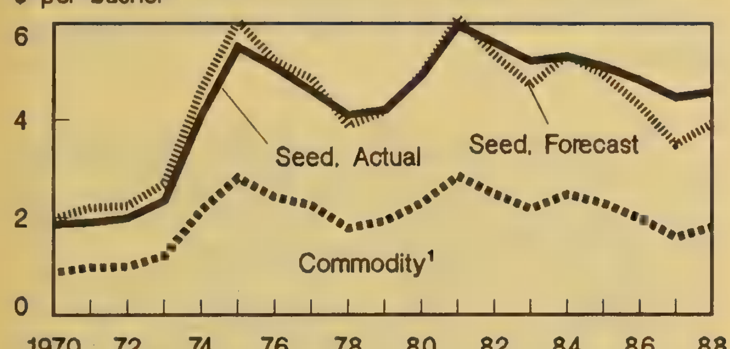
Soybeans

$ per bushel



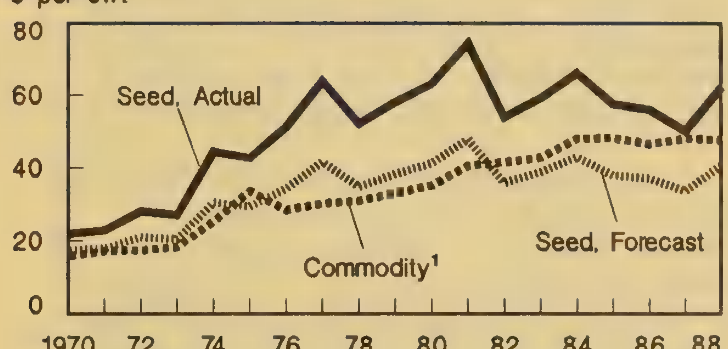
Barley

$ per bushel



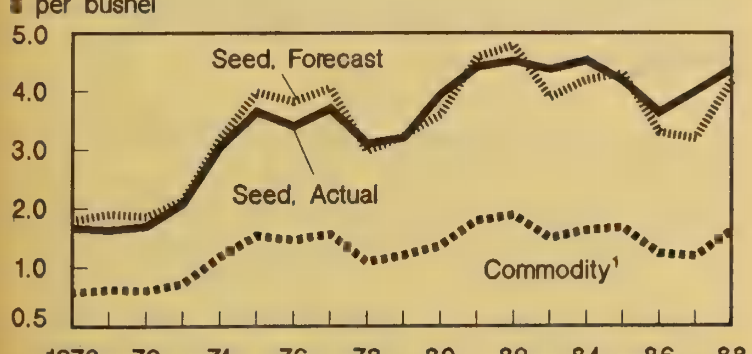
Cotton

$ per cwt



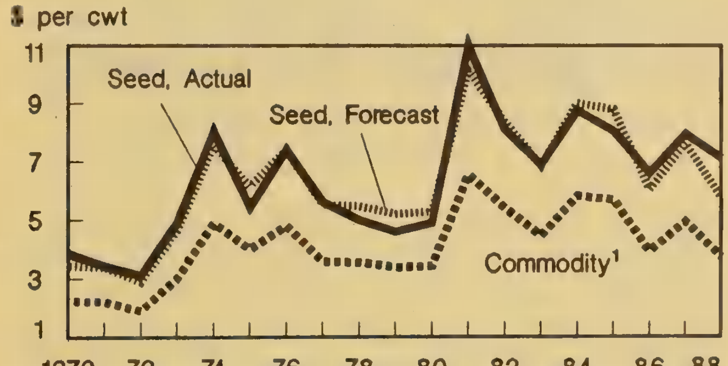
Oats

$ per bushel



Potatoes

$ per cwt



1/ Commodity prices lagged 1 year.

Table 27.--Hybrid seed prices regressed on lagged commodity prices and time trend

Crops	Constant	Coefficient: Commodity	Coefficient: Time	Statistic: R squared	Statistic: TPE	Statistic: U2	1988 seed price: Unit	1988 seed price: Forecast 1/	1988 seed price: Actual 2/	Difference
								Dollars		Percent
Corn	5.66	17.99 (2.97)	-	0.35	4	3.94	Bu	36.06	68.69	-48
	5.13	3.56 (2.86)	3.50 (22.39)	.98	6	.73	Bu	76.83	"	12
Grain sorghum	15.17	8.14 (2.42)	-	.27	6	3.60	Bu	37.06	65.70	-44
	12.25	1.12 (1.17)	3.00 (15.41)	.96	4	.84	Bu	71.63	"	9

Note: t-values in parentheses.

1/ Using 7 month (October 87-April 88) average price received by farmers for corn and grain sorghum. 2/ April 1988 prices.

While the final models presented appeared to forecast well, an attempt was made to compare the resulting forecasts with an even simpler model. Using Thiel's inequality statistic (U2), the authors' forecasts were compared with those derived from simply using last year's seed price to forecast this year's seed price. A U2 value close to zero indicates perfect predictive power. Values close to one or larger reveal poor predictive power and suggest that it would be just as well to use this year's seed price to predict next year's price. In all cases except cotton, the final models presented had U2 values less than one, which implies that the final equations tracked well within the sample period.

The number of turning point errors (TPE) was also used to evaluate and compare forecast accuracy. TPE are not just errors of magnitude but are forecasts that miss the direction of the actual values. For example, the cotton and corn models made 6 turning point errors out of 18 forecasts, or 1 year in 3. The soybean model, on the other hand, made no turning point errors out of 18 forecasts, showing perfect forecast direction.

Future Research Considerations

Further refinements of this model are of course possible, and perhaps even more importantly, the forecasting properties of the model should be more fully investigated. Particular attention should be paid to out-of-sample forecasting results as well as use of autoregressive models. Random coefficient models represent another approach that could be employed. Further investigation of how target prices, loan rates, or futures prices are related to seed prices could also prove beneficial.

From a conceptual economic framework, essentially a reduced form equation is examined in this analysis with little discussion of the underlying structural model. Subsequent work should focus on seed supply and demand relationships where supply is influenced by factors such as weather, foreign trade, and seed inventory, while demand is influenced by current or forecast commodity prices. However, the availability of data limits this approach.

FERTILIZER

Use

Plant nutrient use is estimated to have increased slightly to about 19.4 million tons in the 1987/88 fertilizer year (July 1-June 30). The increase, the first since 1984 when PIK-idled acreage returned to production, was primarily due to stable crop acreage and higher commodity prices. Corn acreage, which accounts for over 40 percent of plant nutrient use, increased almost 3 percent in 1988 after falling 14 percent in 1987. However, total planted area of the principal crops was close to the year-earlier level.

While spring 1988 fertilizer prices were above year-earlier levels, particularly for potash, prices at planting for most major crops also increased substantially. Although loan rates and target prices have been reduced, prices received by farmers for corn and soybeans were up over 20 percent, while cotton and wheat prices rose nearly 20 and 10 percent, respectively. Consequently, nitrogen and phosphate application rates in 1988 for corn, cotton, and soybeans probably increased somewhat from 1987 levels, while application rates for wheat likely remained unchanged. Potash application rates may have declined slightly as potash prices rose almost 37 percent.

The impacts of the drought on fertilizer use will be negligible in 1987/88 because most fertilizer is applied at planting. Slight reductions in nitrogen use may have occurred as corn is typically side dressed in June, but the impact on overall use was likely limited. However, with a continued drought, commodity stocks will be reduced and crop prices increased. This should lead to increased crop acreage and fertilizer use in 1989.

Supplies

Domestic fertilizer supplies in 1987/88 increased from a year ago for each of the primary plant nutrients. While beginning inventories were below year-earlier levels, they were more than offset by increased production. Nitrogen supplies were up 2 percent during July-May, even though net imports declined, as production rose 9 percent (table 28). Phosphate supplies increased 17 percent due to a 10-percent increase in production. An increase in potash imports, in addition to increased production, resulted in a 12-percent rise in potash supplies.

Table 28.--U.S. fertilizer supplies 1/

Item	1986/87	1987/88	Change
	Million short tons		Percent
July 1 inventory:			
Nitrogen (N)	1.88	1.36	-28
Phosphate (P_2O_5) 2/	.63	.51	-19
Potash (K_2O)	.29	.22	-25
Production:			
Nitrogen	11.36	12.37	9
Phosphate 2/	9.28	10.23	10
Potash	1.24	1.40	13
Imports:			
Nitrogen	3.63	3.76	3
Phosphate 2/	.11	.15	39
Potash	4.07	4.50	11
Exports:			
Nitrogen	2.48	2.75	11
Phosphate 2/	4/ 3.89	4/ 3.75	-4
Potash	.57	.48	-16
Domestic supply: 3/			
Nitrogen	14.40	14.73	2
Phosphate 2/	4/ 6.12	4/ 7.14	17
Potash	5.04	5.65	12

1/ Data for July through May for the fertilizer year starting July 1. 2/ Does not include phosphate rock. 3/ Includes requirements for industrial uses. 4/ Does not include exports of superphosphoric acid because of a data reporting change by the U.S. Department of Commerce in July 1985. Thus, phosphate exports are understated and domestic supply is overstated.

Trade

The declining value of the U.S. dollar and increased world fertilizer demand turned 1987/88 into another good year for nitrogen and phosphate exports. U.S. nitrogen exports during July-May increased 11 percent, while phosphate exports fell 4 percent from what was a strong export market in 1986/87. Potash exports of over 477,000 tons were off 16 percent from a year earlier.

Exports of nitrogen solutions, historically not a major fertilizer export item, increased almost 550 percent to 797,666 tons, as France purchased 523,669 tons through May 1988. Urea exports also advanced 49 percent during July-May, primarily because of increased purchases by China. Because of the Chinese government's heightened emphasis on grain

production, urea exports to China more than doubled to 475,209 tons and accounted for nearly half of all urea exports. U.S. urea exports also increased to the EC, as an anti-dumping case against Eastern Bloc imports opened the market for other suppliers. However, the decision by CMC Engrais, the European fertilizer producer association, to extend the dumping investigation to additional countries including the United States, could dampen future U.S. exports to the EC. Exports of anhydrous ammonia and ammonium sulfate, which accounted for almost 32 percent of nitrogen exports, fell 15 and 16 percent, respectively.

Diammonium phosphate (DAP) exports, which grew 12 percent during July-May, kept the strong export market for phosphates alive in 1987/88. Along with a 23-percent increase in exports of monammonium phosphate, the increase in DAP exports helped offset declines of 52 and 35 percent in phosphoric acid and triple superphosphate exports, respectively. DAP purchases by China rose 88 percent to 1.87 million tons, and accounted for most of the growth in DAP exports. China's DAP purchases have been highly volatile in the past as changes in policy have affected fertilizer purchases. While the current Chinese policy emphasizes increased grain production, China essentially removed itself from the market in 1985/86 in an effort to conserve foreign exchange.

U.S. potash exports were mixed, declining 16 percent overall, as exports of potassium chloride fell 32 percent. A substantial increase in exports to Brazil, which accounted for more than half of total potassium chloride exports through May, prevented an even greater decline. However, exports of potassium sulfate rose over 43 percent, partially offsetting the decline in potassium chloride exports.

Nitrogen imports were up 3 percent overall, as imports of anhydrous ammonia increased 30 percent, offsetting a 30-percent decrease in urea imports. Higher anhydrous imports were due primarily to increased shipments from Canada and the Soviet Union, which together accounted for nearly 80 percent of U.S. anhydrous ammonia imports. The fall in urea imports was led by a 361,217-ton decrease from the Soviet Union, as the anti-dumping suit against Eastern Bloc countries discouraged imports from that region.

Potash imports from July 1987 through May 1988 increased 11 percent, as the anti-dumping case against Canadian producers was settled. In January, eight Canadian potash producers and the U.S. Department of Commerce (DOC) signed an agreement to end the anti-dumping case. Under the agreement, Canadian producers are restricted from dumping potash in the United States at more than 15 percent of the preliminary margins set by DOC in August 1987. Despite the significant price increase resulting from the case, imports of potassium chloride from Canada increased almost 3 percent and accounted for nearly 88 percent of total potassium chloride imports through May. Additional increases in potassium chloride imports came from Israel and the Soviet Union.

Production

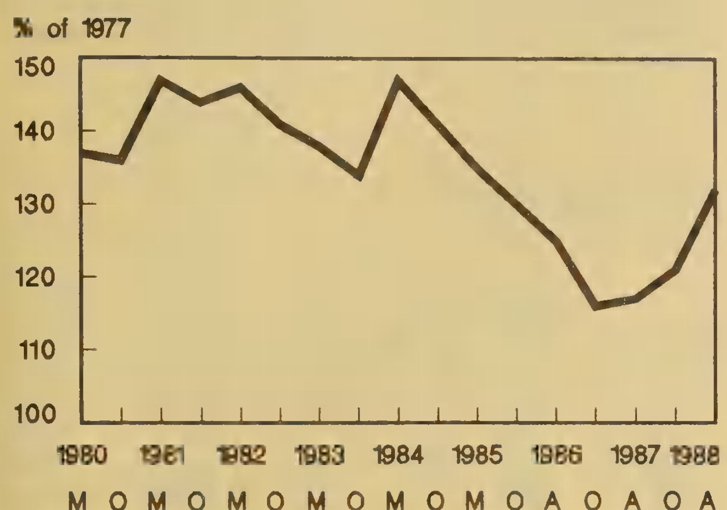
Domestic fertilizer production increased for each of the primary plant nutrients during 1987/88 in response to higher prices. Nitrogen production rose 9 percent during July-May as increased exports of urea and nitrogen solutions augmented the small upturn in domestic demand. Phosphate production advanced 10 percent while potash production was up 13 percent.

Prices

Spring 1988 farm fertilizer prices increased 9 percent from October 1987 and stood almost 13 percent above year-earlier levels (table 29). The increases resulted from low inventories, stable-to-increasing domestic consumption, and a strong export market for nitrogen and phosphate fertilizers. Significant increases in potash prices resulted primarily from the anti-dumping case against Canadian potash producers. The increase in average fertilizer prices continued the gradual turnaround that began in 1987 and marked the first significant price rise since 1984, when PIK-idled acreage returned to production. While spring 1988 prices increased significantly, average prices paid remained below spring 1985 levels and were more than 10 percent below the peak levels of 1981, 1982, and 1984.

Anhydrous ammonia prices rose more than 11 percent from April 1987 to April 1988, as prices for other nitrogen materials increased from 6 to 26 percent. Triple superphosphate and diammonium phosphate prices were up 14 percent. Potash prices increased the most—nearly 37 percent from a year earlier—and reached their highest level on record.

U.S. Fertilizer Price Index



May and October data for 1980-85, April and October data for 1986-88.

The U.S. Department of Transportation (DOT), in an attempt to simplify and reduce the number of regulations governing the packaging and transportation of hazardous materials and facilitate international commerce, has proposed to reclassify anhydrous ammonia from a "nonflammable" to a poisonous gas and align the United States with United Nations' standards. Anhydrous ammonia currently is treated as a poisonous gas in international shipments. The reclassification could become effective in 2 years and could have a significant impact on product shipping, transportation routes, insurance rates, and marketing costs. The increased costs likely will be passed on to the farmer.

Table 29.--Average U.S. farm prices for selected fertilizer materials 1/

Year	Anhydrous ammonia (82%)	Triple super-phosphate (44-46%)	Diammonium phosphate (18-46-0%)	Potash (60%)	Mixed (6-24-24%)	Prices paid index 1977=100
	Dollars per short ton					
1985	252	203	240	128	192	135
1986	225	190	224	111	179	125
1987	187	194	220	115	176	117
1988	208	222	251	157	208	132

1/ Based on surveys of farm supply dealers conducted by the the National Agricultural Statistics Service, USDA. Prices are for May in 1985 and April in 1986-88.

USE OF MANURE, LIME, SULPHUR, AND MICRONUTRIENTS ON SELECTED CROPS, 1987

by

Harry Vroomen

Most currently available data on fertilizer use concern the primary plant nutrients, nitrogen, phosphorus, and potassium. Emphasis is generally placed on these nutrients because of their contribution to increased yields and the large quantities consumed each year. However, manure, lime, sulphur, and micronutrients also provide essential elements and correct chemical and physical soil conditions, and thereby enhance plant growth.

Detailed data on the use of manure, lime, sulphur, and micronutrients are available for five principal crops for 1987. The proportion of corn, cotton, sorghum, soybean, and wheat acres receiving manure, lime, sulphur, and micronutrients was obtained in the 1987 Cropping Practices Survey conducted in conjunction with objective yield surveys by the National Agricultural Statistics Service. The surveys cover principal producing States, which account for 77-99 percent of the harvested acres of the selected crops. Estimates are based on a stratified, random sampling procedure of fields in the States shown for each crop.

Table 30.—Manure, lime, sulphur, and micronutrient use on corn for grain, 1987

State	October 1 harvested acreage	Number of samples	Acres receiving: Manure	Lime	Sulphur	Micro-nutrients
	Thousand		Percent			
Illinois	9,200	241	10	2	1	2
Indiana	4,750	181	15	3	1	4
Iowa	10,050	207	23	1	3	3
Michigan	1,950	104	13	1	1	11
Minnesota	5,000	177	21	1	4	6
Missouri	2,150	123	3	3	2	2
Nebraska	6,200	206	1	1	11	17
Ohio	3,000	164	17	1	3	6
South Dakota	2,700	124	15	nr	nr	1
Wisconsin	2,850	157	43	4	3	4
Area 1/	47,850	1,684	16	2	3	5

nr = none reported.

1/ States in survey harvested 80 percent of U.S. total corn acreage for grain in 1987.

Manure

Manure can be an effective source of nutrients for most crops. Those with a relatively high nitrogen requirement, such as corn, are most likely to respond to its application. However, bulkiness and a relatively low nutrient content reduce manure's competitive economic value. Consequently, manure use is highest in those areas where animal production is common.

Manure was applied to 16 percent of all corn acres surveyed in 1986/87 (table 30). At 43 percent, use was greatest in Wisconsin, where it is more readily accessible because of the State's extensive dairy operations. Manure use also exceeded 20 percent in Iowa and Minnesota, and generally exceeded 10 percent in the major corn-producing States. Use on other crops surveyed was less common, ranging from 2 percent for sorghum to 4 for soybeans (tables 31-34). However, 12-14 percent of the acres of selected cotton and wheat States did receive manure in 1986/87.

Lime

Maintaining a soil's pH (a measure of its acidity or alkalinity) through the application of lime increases the yield potential of crops by improving the availability of soil nutrients. Optimal pH levels are crop dependent, but most crops prefer levels in the range of 6.5 to 7.0. While pH levels vary throughout the United States, soils in the Far West are generally more alkaline (pH > 7.0), while soils

Table 31.—Manure, lime, sulphur, and micronutrient use on upland cotton, 1987

State	October 1 harvested acreage	Number of samples	Acres receiving: Manure	Lime	Sulphur	Micro-nutrients
	Thousand		Percent			
Arizona	308	84	12	nr	6	1
Arkansas	640	101	2	1	5	17
California	1,120	259	13	nr	*	6
Louisiana	600	92	1	9	3	4
Mississippi	1,090	162	1	2	4	15
Texas	4,250	543	1	nr	10	8
Area 1/	8,008	1,241	3	1	7	9

* = Less than 1 percent.
nr = none reported.

1/ States in survey harvested 80 percent of U.S. total cotton acreage in 1987.

Table 32.—Manure, lime, sulphur, and micronutrient use on grain sorghum, 1987

State	October 1 harvested acreage	Number of samples	Acres receiving: Manure	Lime	Sulphur	Micro-nutrients
	Thousand		Percent			
Kansas	3,700	208	3	nr	1	3
Missouri	770	84	nr	nr	nr	nr
Nebraska	1,220	135	3	nr	2	5
Texas	2,450	296	1	nr	2	2
Area 1/	8,140	723	2	nr	2	3

nr = none reported.

1/ States in survey harvested 77 percent of U.S. total grain sorghum acreage in 1987.

Table 33.—Manure, lime, sulphur, and micronutrient use on soybeans, 1987

State	October 1 harvested acreage	Number of samples	Acres receiving: Manure	Lime	Sulphur	Micro-nutrients
	Thousand		Percent			
Alabama	500	88	1	3	5	6
Arkansas	3,350	133	nr	nr	nr	1
Georgia	800	75	nr	5	3	1
Illinois	8,750	182	2	3	nr	nr
Indiana	4,350	107	4	4	nr	2
Iowa	8,050	157	9	nr	nr	1
Kentucky	1,020	94	1	2	1	2
Louisiana	1,660	99	nr	1	nr	nr
Minnesota	4,700	100	7	nr	nr	nr
Mississippi	2,450	111	nr	1	nr	1
Missouri	4,900	148	nr	1	nr	nr
Nebraska	2,350	77	3	nr	1	nr
North Carolina	1,300	77	3	6	1	1
Ohio	4,080	126	8	nr	1	2
Tennessee	1,250	96	2	1	nr	1
Area 1/	49,510	1,670	4	1	*	1

* = Less than 1 percent.
nr = none reported.

1/ States in survey harvested 87 percent of U.S. total soybean acreage in 1987.

in the Pacific Northwest are typically pH neutral. As one moves further east and south, the soils become more acidic.

Lime is generally applied as ground agricultural limestone with the frequency of application varying by crop and region. The frequency of lime applications can range from every year on highly acidic soils to every 5-10 years in the Midwest. Among the crops surveyed, use ranged from an average of 2 percent on corn acres to no applications on grain sorghum. Nine percent of cotton acres in Louisiana and 8 percent of soybean acres in North Carolina received lime in 1986/87, while applications in most other States for the crops surveyed were below 4 percent.

Table 34.--Manure, lime, sulphur, and micronutrient use on wheat, 1987

State	October 1 harvested acreage	Number of samples	Acres receiving			
			Manure	Lime	Sulphur	Micro-nutrients
	Thousand		Percent			
Winter wheat:						
Arkansas	840	71	nr	nr	3	nr
California	480	70	2	nr	3	nr
Colorado	2,500	88	1	nr	1	nr
Idaho	800	92	4	nr	46	1
Illinois	950	78	9	3	1	nr
Indiana	600	60	14	2	nr	3
Kansas	9,900	244	3	*	1	1
Missouri	770	74	nr	1	6	2
Montana	2,200	105	1	nr	4	nr
Nebraska	1,950	100	1	nr	1	2
Ohio	800	76	5	3	1	nr
Oklahoma	4,800	165	1	nr	2	1
Oregon	750	102	*	nr	29	nr
Texas	3,600	181	12	nr	4	4
Washington	1,825	164	1	1	53	1
Area	32,765	1,670	3	*	7	1
Spring wheat:						
Idaho	340	53	nr	nr	15	nr
Minnesota	2,400	64	3	nr	nr	nr
Montana	2,300	67	nr	nr	3	nr
North Dakota	6,100	109	3	nr	nr	1
South Dakota	1,800	57	12	nr	nr	nr
Area	12,940	350	4	nr	1	*
Durum wheat:						
North Dakota	2,850	131	2	nr	nr	nr
All wheat:						
Arkansas	840	71	nr	nr	3	nr
California	480	70	2	nr	3	nr
Colorado	2,500	88	1	nr	1	nr
Idaho	1,140	145	3	nr	37	1
Illinois	950	78	9	3	1	nr
Indiana	600	60	14	2	nr	3
Kansas	9,900	244	3	*	1	1
Minnesota	2,400	64	3	nr	nr	nr
Missouri	770	74	nr	1	6	2
Montana	4,500	172	1	nr	4	nr
Nebraska	1,950	100	1	nr	1	2
North Dakota	8,950	240	3	nr	nr	1
Ohio	800	76	5	3	1	nr
Oklahoma	4,800	165	1	nr	2	1
Oregon	750	102	*	nr	29	nr
South Dakota	1,800	57	12	nr	nr	nr
Texas	3,600	181	12	nr	4	4
Washington	1,825	164	1	1	53	1
Area 1/	48,555	2,151	3	*	5	1

* = Less than 1 percent.
nr = none reported.

1/ States in survey harvested 83, 99, and [illegible] percent of U.S. total winter, spring, and durum wheat, respectively, in 1987.

Sulphur

As with the other essential nutrients, sulphur plays a unique role in plant growth. Plants that are deficient in sulphur are often small and spindly, while the younger leaves are light green to yellowish in color. In the case of legumes, sulphur deficiencies can lead to reduced root nodulation (1).

In 1986/87, sulphur was used on 7 percent of the cotton acreage in the surveyed States, as 10 percent of the acreage in Texas received sulphur. Sulphur was used on 3 percent of the corn acreage and 2 percent of the sorghum acreage, while Georgia and Alabama were the only soybean-producing States surveyed where more than 1 percent of the acres received sulphur. For all wheat, 5 percent of the acreage received sulphur. Selected wheat-producing States, however, applied sulphur to a significant proportion of acreage. Idaho, Oregon, and Washington applied sulphur to 37, 29, and 53 percent of wheat acres, respectively, because soils in the Pacific Northwest are deficient in sulphur.

Micronutrients

Micronutrients, or trace elements, are also essential for plant growth, but are generally required in smaller quantities than other nutrients. The elements normally classified as micronutrients include boron, chlorine, cobalt, copper, iron, manganese, molybdenum, and zinc. Calcium and magnesium, often referred to as secondary nutrients, have been included with the micronutrients in this report, although they are often used in larger quantities.

Each micronutrient has its own role. Boron functions in cell division and growth, while cobalt and molybdenum are necessary for nitrogen fixation. Copper is required for chlorophyll formation, and chlorine is involved in electron transport during photosynthesis. Iron and manganese act as catalysts during chlorophyll synthesis, while zinc is essential

for plant growth and development. Calcium, and to a lesser extent, magnesium, are often used to neutralize soil acidity (2,3).

Corn for grain.-- Micronutrients were applied to 5 percent of corn acres in 1986/87, with acreage in Nebraska and Michigan receiving the largest proportions at 17 and 11 percent, respectively. The most common micronutrient used by corn growers was zinc, which accounted for 75 percent of all micronutrient applications (table 35). Boron, magnesium, calcium, and manganese accounted for an additional 21 percent of all micronutrient use on corn.

Cotton.-- About 9 percent of cotton acreage received some micronutrients in 1986/87, the highest proportion among the crops surveyed. Boron was the most common micronutrient used on cotton, accounting for 60 percent of all micronutrient use, followed by zinc at 24 percent. Arkansas and Mississippi had the greatest proportion of cotton acres receiving micronutrients at 17 and 15 percent, respectively.

Table 35.--Distribution of micronutrients used on selected crops, 1987

	Corn	Cotton	Grain sorghum	Soybeans	All wheat
			Percent		
Proportion of crop acres receiving micronutrients	5	9	3	1	1
Micronutrients applied:					
Boron	7	60	nr	32	9
Calcium	5	1	nr	16	14
Copper	2	nr	nr	nr	9
Iron	2	7	nr	4	nr
Magnesium	5	6	9	16	4
Manganese	4	1	4	16	nr
Molybdenum	nr	1	nr	4	nr
Zinc	75	24	87	12	64
Total	100	100	100	100	100

nr = none reported.

Grain sorghum.-- Micronutrients were applied to 3 percent of grain sorghum acres in 1986/87, as use ranged from 5 percent in Nebraska to no applications reported in Missouri. Zinc was the predominant micronutrient used, accounting for 87 percent of all applications. Magnesium and manganese were the only other micronutrients used on grain sorghum.

Soybeans.-- Micronutrient use on soybeans was less prevalent. Only 1 percent of soybean acres received micronutrients in 1986/87. Use stood at 2 percent or less in all States surveyed except Alabama, where 6 percent of the acreage received micronutrients. After boron, which accounted for 32 percent of all micronutrient use on soybeans, calcium, magnesium, manganese, and zinc accounted for an additional 60 percent of use.

Wheat.-- Micronutrient use was also less common on wheat acreage, as 1 percent of wheat acres received micronutrients in 1986/87. Use stood below 2 percent in all but 4 of the 18 States surveyed, while 9 States reported no micronutrient applications. Zinc was the most frequently applied micro-nutrient on wheat acreage, accounting for 64 percent of total micronutrient use.

References

1. Brady, Nyle C. *The Nature and Properties of Soils.* New York: Macmillan, 1974.

2. The Fertilizer Institute. *The Fertilizer Handbook.* Washington, D.C.: 1982.

3. Martin, J.H., Leonard, W.H., and D.L. Stamp. *Principles of Field Crop Production.* New York: Macmillan, 1976.

USE OF AGRICULTURAL INPUTS AND THE CONSERVATION RESERVE PROGRAM

by

Harold H. Taylor

Abstract: The relative impact of the Conservation Reserve Program on the use of agricultural inputs from 1987 to 1996 was estimated. Four scenarios were evaluated: no–CRP; CRP–benchmark, CRP–forestry, and CRP–environmental. The CRP scenarios resulted in lower use of cropland acreage and agricultural inputs than the no–CRP scenario. Use of agricultural inputs is indicated to be 4 percent lower for CRP scenarios as compared to non–CRP in 1987 and for the 1990–96 period this annual difference was about 10 percent. Cropland acreage and use of inputs varied by region for the different scenarios.

Key Words: Conservation Reserve Program, scenarios, inputs

Introduction

The Conservation Reserve Program (CRP) directly affects the quantity of inputs used to produce farm commodities. The impacts of the CRP on the use of agricultural inputs depend on the amount and type of cropland put into long term vegetative cover, the type of land cover used, and the extent that nonprogram acreage is substituted for CRP selected acreage. This study measures the effects on input use during the period of implementation (1987–1996) for varying CRP options.

The CRP, established in 1985 as part of the Food Security Act (FSA), aims to remove highly erodible cropland from intensive crop production. Under the FSA, up to 45 million acres of the Nation's most erodible and fragile cropland is targeted to be placed in long term vegetative cover by 1990. Landowners and farm operators in cooperation with landowners may enroll eligible cropland during specific signup intervals. No more than 25 percent of the cropland in any one county may be placed in the reserve unless doing so would not hurt local economies.

Landowners and operators desiring to participate in the CRP must agree to implement a plan approved by the local conservation district to place highly erodible cropland into grasses, trees, or other vegetative covers for at least 10 years. They must further agree not to harvest, graze, or make other commercial use of the forage for the duration of the contract. The conservation plan must describe the measures and practices required; the situation under which commercial use would be permitted, such as haying during severe drought; and the amount of cropland base to be retired.

Landowners and operators receive annual rental payments from the Government for the conversion. The amount of the compensation is determined through sealed bids. The acceptability of each bid is determined by the Government based on the least cost. Also, upper limits on bid acceptance have been established at or below cropland rental rates.

Scenario Assumptions

The relative impact of alternative land covers and the use of agricultural inputs from 1987 to 1996 was evaluated using a regional agricultural sector simulation model [1].

[1] The model was developed by C. Robert Taylor with assistance from James S. Eales and Michael D. Frank. Funding for model development was provided by the Economic Research Service, USDA, the Illinois Agricultural Experiment Station, and the University of Illinois Research Board. Detailed information on the model can be obtained from unpublished manuscripts on each model component. Contact the Economic Research Service (202–786–1456) or the University of Illinois for more information.

Regional acreage by crop was forecast and provided the basis for estimating input use. This period provided sufficient time for all contracts to be made and for the initial contracts to expire. The first scenario assumed that a CRP program was not in existence. Then three CRP scenarios were examined: (1) The CRP-benchmark scenario represented implementation of a 45-million-acre reserve. (2) The CRP-forestry scenario assumed that in attempting to reach a 45-million-acre reserve, every effort was made to include 5 million acres of tree cover. (3) The CRP-environmental scenario included, as part of the targeted 45-million-acre reserve, buffer strips along streams and on other acreage where soil is eroding and contributing to surface water quality problems stemming from agricultural production. In addition, the environmental scenario included wetland acres, salt-affected irrigated cropland areas, and areas with a declining groundwater table.

The same total acreage would be set aside each year for the three CRP scenarios from 1987 to 1996; however, the regional distribution would differ among scenarios. For example, with the CRP-forestry scenario more acreage would be set aside in the Appalachian, Southeast, Delta, and Lake States regions of the country than in the CRP-benchmark scenario. This assumption was made because these areas are more suited for forestry. With the CRP-environmental scenario, more acreage would be set aside in the Corn Belt than with the CRP-benchmark scenario since water quality and wetland acreage are major concerns in this region.

The level of agricultural inputs depends on acreage planted and type of crop. Input use for the establishment of permanent vegetation somewhat offsets the decline in use from retired cropland, but only during the establishment year. The amount used is likely modest compared with cropland input use and so is not considered in this analysis.

Analytical Procedures

The total acreage planted, diverted, or set aside under farm programs from 1987 to 1996 was first determined. Acreage by crop and region was then estimated. Yield per acre was multiplied by acreage to calculate production. Inventories were added to production and summed by region to estimate crop supply. Relative prices helped to determine crop demands. Export demand for commodities and their derivatives was estimated through projected world population, prices, exchange rates, and time. Annual equilibrium prices were estimated by equating demand and supply functions. Prices from one year may affect average response the following year.

The level and mix of agricultural inputs per acre for all commodities were assumed constant during the analysis. Projected yields were based on time-trend regression results using data from 1963 to 1984. Yield per acre for all commodities except cotton varied little over the time period. Yield per acre for cotton increased by 1 percent for the no-CRP scenario. It increased by about 6 percent for the three CRP scenarios since more productive land was assumed used in cotton production with the CRP scenarios. This assumption allowed explicit examination of input use changes due to cropland acreage shifts.

Estimated growth in U.S. and world populations was allowed, resulting in increased domestic and world demand for commodities. This increased demand, along with a reduction in planted acres, caused a reduction in inventories and then upward pressure on prices. The higher prices caused a reduction in diverted and hay and fallow acreage and a substitution of pasture and forestry acreage to cropland.

Acreage Under the Various Scenarios

Program crop, hay and fallow, land diversion, and CRP acreage increased from 368 million acres in 1987 to 390 million in 1996 (table 36). Program crop acreage for this analysis includes acreage planted in corn, grain sorghum, barley, oats, wheat, soybeans, and cotton. Commodity price increases during the period resulted in 22 million more farmland acres being used as cropland. Some pasture and forestry acreage was converted to cropland.

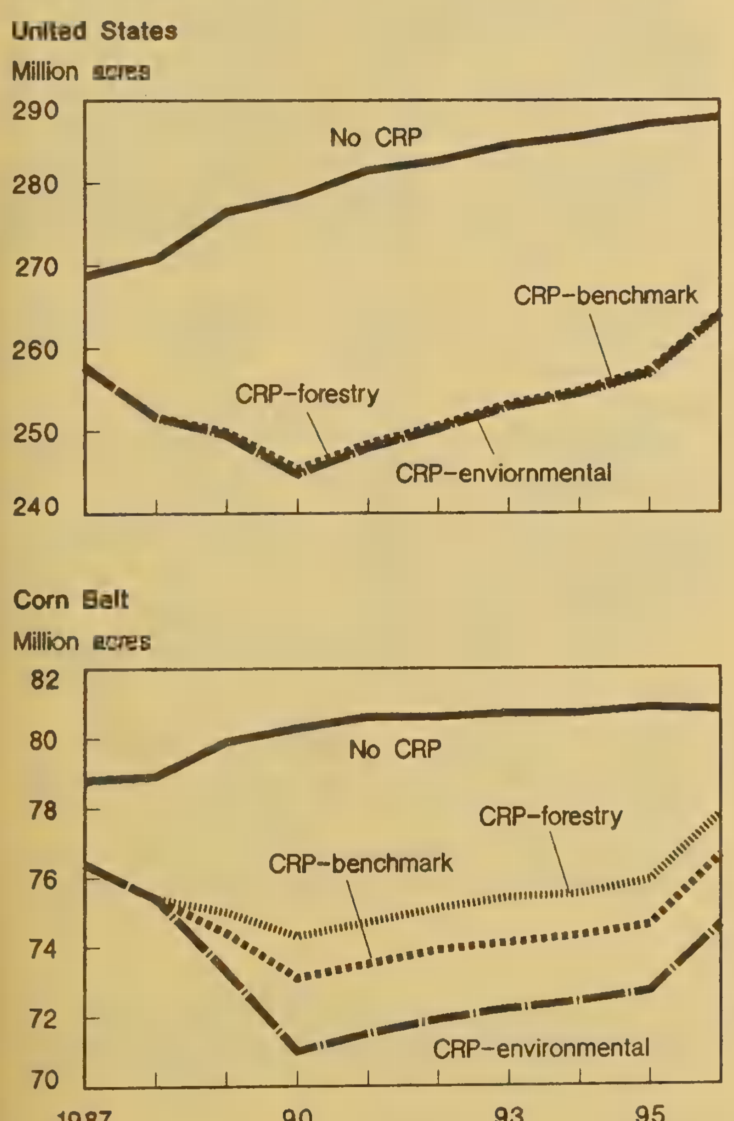
Program crop acreage under the no-CRP scenario varied from 269 million acres in 1987 to 288 million in 1996, while program crop

Table 36.--Summary of acreage with and without Conservation Reserve Program (CRP) for various scenarios

Item	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
					Million acres					
No-CRP scenario:										
Program crop acres 1/	269	271	277	278	281	283	285	286	287	288
Hay and fallow	88	87	88	88	88	88	89	89	90	90
Diverted	11	10	10	11	11	11	12	12	12	12
CRP	0	0	0	0	0	0	0	0	0	0
No-CRP total	368	368	375	377	380	382	386	387	389	390
CRP scenarios:										
Program crop acres	258	252	250	245	248	251	253	255	257	264
Hay and fallow	84	80	80	79	80	80	81	81	82	84
Diverted	11	9	8	7	5	5	5	6	6	7
CRP	16	27	36	45	45	45	45	45	44	36
CRP Total	369	368	374	376	378	381	384	387	389	391

1/ Program crops listed in Table 37.

Projected Planted Acreage of Major Crops



area for the CRP scenarios varied from 258 million acres in 1987 to a low of 245 million in 1990, and increased to 264 million in 1996.

The CRP scenarios reduced total program crop acreage from the no-CRP scenario by 33 million in 1990. This difference is less than the acreage in the Conservation Reserve Program because of substitution of nonprogram (hay, fallow, and land diversion) acreage into CRP acreage. This substitution varied from about 5 million acres in 1987 to around 13 million by 1990.

Area by crop varied less than a million acres among CRP scenarios (table 37). There were no major differences among the CRP scenarios; however, crop mix varied by region to accommodate assumptions for the CRP–forestry and CRP–environmental scenarios. The CRP–benchmark scenario utilized more corn and soybean acreage than the CRP–forestry and CRP–environmental scenarios. The CRP–forestry scenario withdrew less grain sorghum, barley, oats, and wheat acreage from production than the CRP–environmental scenario. The CRP–environmental scenario withdrew more corn, soybeans, and cotton acreage from production than the CRP–forestry scenario.

Regional Evaluation of Acreage

The most significant changes in acreage occurred in the Corn Belt, Northern Plains,

Table 37.--U.S. relative distribution of program crop acreage by crop for various Conservation Reserve Program (CRP) scenarios

Item	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
					1987 No-CRP=100					
No-CRP:										
Corn	100	103	103	101	104	104	104	105	105	107
Grain sorghum	100	100	100	100	100	100	100	100	100	100
Barley	100	92	85	85	85	85	85	85	85	85
Oats	100	100	100	108	108	108	108	108	115	115
Wheat	100	101	104	105	105	105	108	109	109	109
Soybeans	100	100	105	108	110	110	110	110	110	110
Cotton	100	100	108	108	108	108	108	108	108	108
CRP scenarios:										
Corn	97	96	93	89	93	95	96	96	97	100
Grain sorghum	92	85	85	85	85	92	92	92	92	92
Barley	92	85	77	69	69	69	77	77	77	77
Oats	100	85	85	92	85	92	92	92	100	100
Wheat	95	93	91	89	90	90	90	90	91	94
Soybeans	97	97	102	103	103	103	103	105	105	105
Cotton	92	92	92	92	92	83	83	92	92	92

Southeast, and Mountain regions (table 38). The Corn Belt includes Illinois, Indiana, Ohio, Iowa, and Missouri. The Northern Plains region includes North Dakota, South Dakota, Nebraska, and Kansas. The Southeast region includes Alabama, Georgia, South Carolina, and Florida. The Mountain region includes Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico.

The no-CRP scenario showed program crop acreage in the Corn Belt increasing from about 79 million in 1987 to around 81 million in 1996. The CRP-benchmark scenario showed program crop acreage about mid-way between the other two CRP scenarios. The CRP-environmental scenario showed program crop acreage decreasing from 76.4 million in 1987 to 71.0 million in 1990 and then increasing to about 74.6 million in 1996. The CRP-forestry scenario showed program crop acreage decreasing from 76.4 million in 1987 to 74.3 million in 1990 and then increasing to 77.8 million in 1996.

The Northern Plains region's no-CRP scenario had program crop acreage remaining relatively constant from 1987 to 1996 at around 61 million acres with corn, grain sorghum, and barley acreage being reduced and oat, wheat, and soybean acreage being increased. Program crop acreage in the CRP-benchmark scenario decreased from 59.2 million in 1987 to 54 million in 1990 and then

Table 38.--Planted program crop acres by selected regions for the various Conservation Reserve Program (CRP) scenarios

Region and scenario	1987	1990	1996
		Million acres	
Corn Belt:			
No-CRP scenario	78.8	80.3	80.8
CRP-benchmark	76.4	73.1	76.6
CRP-forestry	76.4	74.3	77.8
CRP-environmental	76.4	71.0	74.6
Northern Plains:			
No-CRP scenario	61.1	60.8	60.8
CRP-benchmark	59.2	54.1	55.0
CRP-forestry	59.2	55.1	56.1
CRP-environmental	59.2	55.3	56.2
Mountain:			
No-CRP scenario	19.2	19.6	21.3
CRP-benchmark	17.6	15.6	18.3
CRP-forestry	17.6	16.3	19.0
CRP-environmental	17.6	16.1	18.8
Southeast			
No-CRPscenario	8.3	10.4	12.9
CRP-benchmark	7.7	8.9	11.8
CRP-forestry	7.7	7.7	10.5
CRP-environmental	7.7	9.0	11.9

slowly moved up to 55 million in 1996. The CRP-forestry and CRP-environmental scenarios had acreage patterns similar to each other. Program crop acreage for both decreased from 59.2 million in 1987 to 55.3 million in 1990 and then slowly increased to 56.2 million by 1996.

Program crop acreage distribution for the Southeast region's no-CRP scenario showed acreage increasing from 8.3 million in 1987 to 12.9 million in 1996. Some pasture and forestry acreage were used for program crops. The CRP-benchmark and CRP-environmental scenarios resulted in similar crop acreage. Acreage went from 7.7 million in 1987 to 11.9 million in 1996. Program crop acreage in the CRP-forestry scenario first remained constant at 7.7 million from 1987 to 1990 and then climbed to 10.5 million in 1996.

Program crop acreage distribution for the Mountain region's no-CRP scenario showed it rising from 19.2 million acres in 1987 to 21.3 million in 1996. Acreage slipped from 17.6 million in 1987 to 15.6 million in 1990 in the CRP-benchmark scenario. It then increased to 18.3 million acres in 1996. In both the CRP-forestry and CRP-environmental scenarios, acreage first decreased from 17.6 million in 1987 to 16.3 million in 1990, then increased to 19.0 million in 1996.

Use of Agricultural Inputs Under the Various Scenarios

In this analysis per unit prices for most commodities were allowed to increase from 1987 to 1996. Both domestic and foreign demand for commodities and livestock increased, resulting in reduced stocks and thus higher prices. Use of agricultural inputs such as fertilizer, other chemicals, fuel and energy, and seeds is highly correlated with regional crop acreage by commodity.

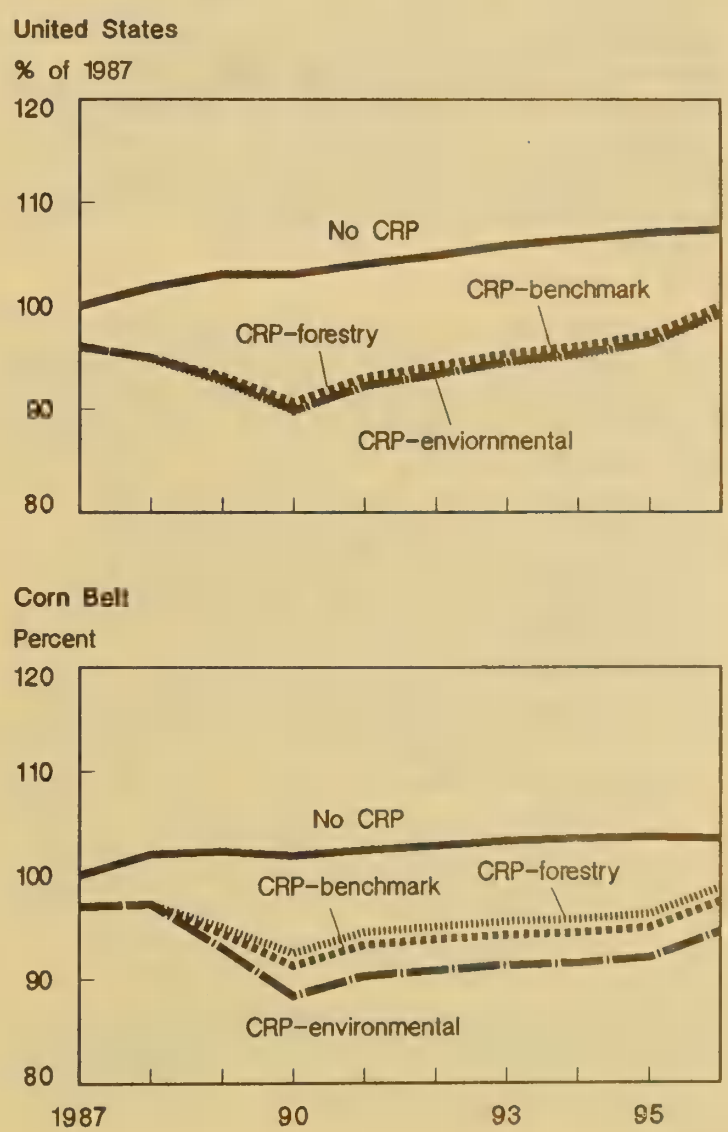
Use of all agricultural inputs increased for the no-CRP scenario each year from 1987 to 1996 as acreage increased. Use increased about 7 percent for fertilizer, 7.5 percent for other chemicals, and 5.5 percent for fuel and energy.

Input use for the CRP scenarios also followed planted acreage. Input use first decreased from 1987 to 1990 and then slowly increased until 1996. In 1987, input use was 4 percent less for the CRP scenarios than without a CRP program and for the 1990-1996 period this annual difference was about 10 percent.

The use of fertilizer declined about 6 percent from 1987 to 1990 for all three CRP scenarios and then slowly increased a total of 10 percent by 1996. In 1996, use of fertilizer for the CRP scenarios was 4 percent greater than in 1987, but was still 7 percent less than under the no-CRP scenario in 1996. Fertilizer use varied by less than 1 percent among the three CRP scenarios.

In 1987, the CRP scenarios used 4 percent less other chemicals than the no-CRP scenario. The no-CRP scenario use of other chemicals increased 7.5 percent by 1996. The

Fertilizer Use as a Share of 1987 No-CRP Use



use of other chemicals with the CRP scenarios first declined 2 or 3 percent to about 93 percent of 1987 use with no CRP program in 1990. Use then increased for the three scenarios by about 8 percent in 1996, or 5 percent above their 1987 level. Among the three CRP scenarios use varied between 1 and 2 percent.

Fuel and energy use increased 5.5 percent from 1987 to 1996 for the no-CRP scenario. The CRP scenarios' use of fuel and energy was estimated to be 4.2 percent less in 1987 than the no-CRP scenario. Use declined another 6 percent by 1990, and then rose each year for the three scenarios for an 8.5-percent increase by 1996.

Regional Input Use

Differences in agricultural input use by region and between the no-CRP scenario and the three CRP scenarios occurred due to variations in cropping patterns and acreage planted per region. Fertilizer use for the no-CRP scenario increased 4.5 percent, 9 percent, and 3 percent in the Southeast, Mountain, and Corn Belt regions, respectively, from 1987 to 1996. Fertilizer use declined in the Northern Plains by 2 percent because harvested acreage, especially corn, fell over this period.

Fertilizer use for the CRP scenarios was less than the no-CRP scenario for all years for all regions. Use generally declined from 1987 to 1990 and then increased from 1990 to 1996 with planted acreage, but varied by region and scenario. In the Southeast, fertilizer use for the CRP-forestry scenario decreased 1.5 percent from 1987 to 1990, increased 3.5 percent from 1990 to 1996, and was over 2 percent higher in 1996 than in 1987. Fertilizer use for both the CRP-benchmark and CRP-environmental scenarios was similar to the CRP-forestry; only about 1 percent more fertilizer was used.

Fertilizer use in the Corn Belt for the CRP scenarios first decreased about 9 percent from 1987 to 1990 and then increased from 7 to 11 percent by 1996, depending upon the scenario. Because diverted acreage and land in hay were converted to program crop acreage between 1990 and 1996, fertilizer use recovered and nearly equaled the 1987 level.

Fertilizer use in the Mountain region for the CRP scenarios first declined 10 percent from 1987 to 1990, then increased more than 20 percent from 1990 to 1996, and was 10 percent above the 1987 level. Use varied about 4 percent among the three scenarios.

Fertilizer use in the Northern Plains showed a rapid drop of 8-10 percent from 1987 to 1990, depending upon the CRP scenario. Use then remained relatively constant from 1990 to 1996. Use in 1996 was about 8 percent less than in 1987.

Regional use of other chemicals and fuel and energy followed similar patterns. Variation by CRP scenario was also similar.

PESTICIDES

Demand

Total 1988 farm pesticide use on major field crops is projected to be 439 million pounds, active ingredients (a.i.), up from 429 million in 1987 (table 39). June 1 planted acreage for the 10 major field crops declined

Table 39.--Projected pesticide use on major U.S. field crops, 1988

Crops	June 1 planted acres	Herbicides	Insecticides	Fungicides
	Million	Million pounds (active ingredients)		
Row:				
Corn	67.5	201	24.8	0.06
Cotton	12.2	19	18.0	.19
Grain sorghum	10.4	10	1.6	0
Peanuts	1.7	6	1.3	6.11
Soybeans	58.5	103	9.0	.06
Tobacco	.6	1	2.4	.31
Total	150.9	340	57.1	6.73
Small grains:				
Barley and oats	23.7	6	.2	0
Rice	2.9	12	.5	.07
Wheat	65.9	14	1.9	.76
Total	92.5	32	2.6	.83
Total	243.4	372	59.7	7.56
1987 total	245.5	365	56.6	6.96

slightly from 245.5 million in 1987 to 243.4 million. However, planted acreage for several crops that are major users of pesticides increased in 1988. Corn acreage is projected to be up 1.8 million, cotton 1.7 million, soybeans 1.1 million, rice 531,000, and peanuts 113,000.

The drought will have only a minimal impact on the quantity of herbicides used in 1988. About 85 percent of herbicide treatments are applied preplant or preemergence around planting time. Fewer postemergence treatments will likely be made because they will be uneconomical given the current situation.

A majority of the corn insecticides are applied at planting for corn rootworm larvae control. European cornborers have not been much of a problem this year because dry weather earlier this year interfered with mating and egg survival.

Cotton is the other major user of insecticides, primarily for boll weevil and budworm-bollworm control. The boll weevil problem has been lower than anticipated because of the hot, dry spring. The dry weather also affected the budworm-bollworm complex by reducing egg and small larvae survival. However, increased precipitation could change this situation rapidly.

Prices

The increased planted acreage of pesticide-intensive crops created a greater demand, resulting in increased pesticide prices in 1988. The general price increase for most herbicides and insecticides is the first in the 1980's (table 40). With the depressed agricultural situation in the early part of this decade, pesticide prices remained stable or declined while pesticide manufacturing costs rose. Dealer costs also have risen, especially for liability insurance, causing more upward pressure on retail prices.

Average farm-level herbicide prices rose 3.7 percent between 1987 and 1988. The greatest increase was 5.4 percent for alachlor, a major corn and soybean herbicide. Last year, alachlor prices declined 5.1 percent because of a cash rebate program. Even with the increases, prices of several popular herbicides are lower this year than they were in 1982. For example, the cost per pound a.i. in 1982 for atrazine was $2.68; trifluralin - $8.55, and 2,4-D - $2.80.

Table 40.--U.S. average farm retail pesticide prices

Pesticide 1/	1986	1987	1988	Change 1987-88
	Dollars per pound 5/			Percent
Herbicides:				
Alachlor	5.10	4.84	5.10	5.4
Atrazine	2.15	2.20	2.28	3.6
Butylate	3.10	3.04	3.10	2.0
Cyanazine	4.55	4.63	4.78	3.2
Metolachlor	6.05	6.03	6.21	3.0
Trifluralin	6.25	6.30	6.45	2.4
2,4-D	2.26	2.44	2.53	3.7
Composite 2/	4.05	4.05	4.20	3.7
Insecticides:				
Carbaryl	3.91	3.90	4.06	4.1
Carbofuran	10.27	9.57	9.36	-2.2
Chlorpyrifos	8.30	8.25	8.50	3.0
Fonofos	8.82	8.70	8.83	1.5
Methyl parathion 3/	2.74	2.82	2.94	4.3
Phorate	6.54	6.59	6.68	1.4
Synthetic pyrethroids 4/	51.20	48.80	50.00	2.5
Terbufos	9.79	9.79	9.88	.9
Composite 2/	10.27	10.25	10.57	3.1

1/ Derived from the April survey of farm supply dealers conducted by the National Agricultural Statistics Service, USDA. 2/ Includes above materials and other major materials but not products registered in the last 2 to 3 years. 3/ Supplied by Fred Cooke, Mississippi Agricultural Experiment Station. 4/ Average of fenvalerate and permethrin prices based on 2.5 pounds active ingredient per gallon. 5/ Active ingredients.

Farm-level insecticide prices are projected to be up 3.1 percent this year after holding steady the last 2 years. Methyl parathion prices are up 4.3 percent following a 3-percent increase in 1987. Methyl parathion is used extensively to control boll weevils in cotton production. The boll weevil population was large in early 1987, requiring above-average insecticide use, which led to tight methyl parathion supplies. Spring trappings in 1988 again indicated the possibility of heavy boll weevil pressure.

Regulatory Actions

Following is a summary of Special Reviews being conducted by the EPA for pesticides used in agriculture. The public is

informed of the initiation of a Special Review with the publication of the risk analyses, Position Document (PD) 1. EPA presents its proposed regulatory decision in PD 2/3. After a period of public comment and scientific review, a final position document (PD 4) is published, delineating EPA's regulatory decision.

Special Reviews by EPA

Common Name	Category	Major Use	Possible Risk	Status
Aldicarb	Insecticide, nematicide	Peanuts, potatoes, cotton, citrus	Acute toxicity	PD 2/3, FY 88
Amitrole	Herbicide	Non-crop areas	Carcinogen	PD 2/3, FY 89
Captan	Fungicide	Apples, peaches, seed treatment	Tumors, birth defects	PD 4, FY 88
Chlorothalonil	Fungicide	Peanuts	Tumors	PD 1, FY 88
Carbofuran	Insecticide	Corn, peanuts, sorghum, sunflowers	Wildlife, bald eagles	PD 2/3, spring 1988
EBDC's	Fungicides	Apples, potatoes, tomatoes, citrus	Carcinogen, birth defects	PD 2/3, FY 89
Dinocap	Fungicide	Apples	Birth defects	PD 4, fall 1987
Linuron	Herbicide	Corn, fruits, vegetables	Carcinogen	PD 2/3, FY 88
Parathion	Insecticide	Wheat, sorghum, fruits	Acute human toxicity	PD 1/2/3, spring 1988
Phosdrin	Insecticide	Vegetables, fruits	Acute human toxicity	PD 1, FY 88

LIST OF TABLES

NEW EXPANDED SERVICE!

NOW GET ALL THE ECONOMIC RESEARCH SERVICE PERIODICALS , DIRECT.

ONE PHONE CALL--(301) 953-2515. ONE PAYMENT--check, money order, pay later. UP TO 3 YEARS--check the discounts. SUBSCRIBE TODAY!
Check the subscriptions you want.

SITUATION & OUTLOOK REPORTS	1 Year	2 Years	3 Years
Agricultural Exports (4 issues)	_$10	_$19	_$27
Agricultural Income & Finance (4)	_ 10	_ 19	_ 27
Agricultural Resources (5)	_ 10	_ 19	_ 27
Aquaculture (2)	_ 10	_ 19	_ 27
Cotton & Wool (4)	_ 10	_ 19	_ 27
Dairy (5)	_ 10	_ 19	_ 27
Feed (4)	_ 10	_ 19	_ 27
Fruit & Tree Nuts (4)	_ 10	_ 19	_ 27
Livestock & Poultry (6) Plus 2 data supplements	_ 15	_ 29	_ 42
Oil Crops (4)	_ 10	_ 19	_ 27
Rice (3)	_ 10	_ 19	_ 27
Sugar & Sweetener (4)	_ 10	_ 19	_ 27
Tobacco (4)	_ 10	_ 19	_ 27
Vegetables & Specialties (3)	_ 10	_ 19	_ 27
Wheat (4)	_ 10	_ 19	_ 27
World Agriculture (3)	_ 10	_ 19	_ 27
World Agriculture Regionals (4)	_ 10	_ 19	_ 27
OTHER PERIODICALS			
Agricultural Outlook (11 issues)	_ 22	_ 43	_ 63
Economic Indicators of the Farm Sector (5)	_ 12	_ 23	_ 33
Farmline (11)	_ 11	_ 21	_ 30
Foreign Agricultural Trade of the United States (6) Plus calendar and FY supplements	_ 20	_ 39	_ 57
Journal of Agricultural Economics Research (4)	_ 7	_ 13	_ 18
National Food Review (4)	_ 10	_ 19	_ 27
Rural Development Perspectives (3)	_ 9	_ 17	_ 24
TOTAL	$______	$______	$______

Foreign customers: Add 25 percent for subscriptions mailed outside the United States.

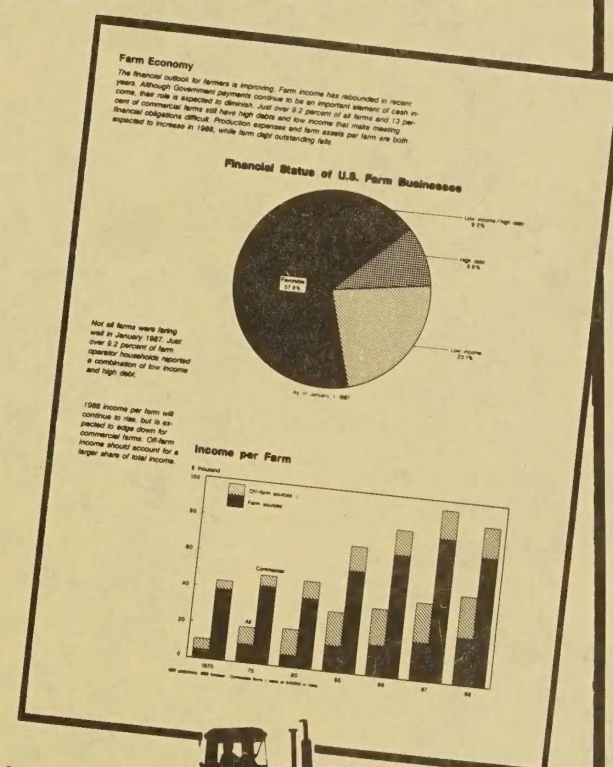
HOW TO ORDER : For fastest service or more information, call (301) 953-2515. Or mail this entire form to:

USDA/ERS
Box 1608
Rockville, MD 20850

___Please bill me.
Enclosed is a check or money order for $_______.
Make payable to USDA/ERS.

Name		Daytime Phone ( )
Organization		
Address		
City	State	Zipcode

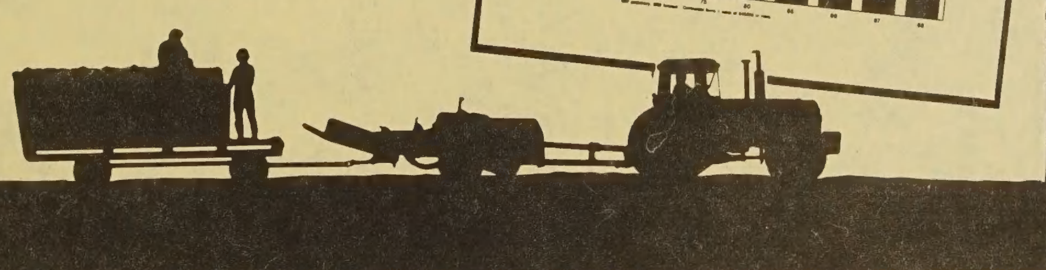
1988 Agricultural Chartbook



The 1988 Agricultural Chartbook presents an overview of the current economic health of the American farm sector. Charts move from the national to the international arenas to farm economic health measures and crop and livestock trends. Background charts cover topics ranging from farm numbers and population to natural resources, the consumer, world production and trade, and domestic commodity trends.

All charts are reproduced in black and white, suitable for photocopying. AH-673. 112 pages. $5.00. Order SN: 001-019-00582-3 from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Or call (202) 783-3238.

An enlargements version of this chartbook, with each chart on a page of its own, is also available from GPO.



*U. S. GOVERNMENT PRINTING OFFICE:1988-201-025:60863/ERS

United States
Department of Agriculture
1301 New York Avenue N. W.
Washington, D. C. 20005-4788

OFFICIAL BUSINESS
Penalty for Private Use, $300

FIRST-CLASS MAIL
POSTAGE & FEES PAID
U.S. Dept. of Agriculture
Permit No. G-145

Moving? To change your address, send this sheet with label intact, showing new address, to EMS Information, Rm. 228, 1301 New York Ave., N.W. Washington, D.C. 20005-4788